EXHIBIT A
Partially Redacted
Public Version

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA
SAN JOSE DIVISION

CISCO SYSTEMS, INC., Plaintiff, v. ARISTA NETWORKS, INC., Defendant.	Case No. 5:14-cv-05344-BLF (PSG)

OPENING EXPERT REPORT OF KEVIN ALMEROTH REGARDING COPYING

SUBMITTED ON BEHALF OF CISCO SYSTEMS, INC.

CONTAINS HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY INFORMATION AND SOURCE CODE

TABLE OF CONTENTS

Page

I. INTRODUCTION 2

II. BACKGROUND & QUALIFICATIONS 2

A. Qualifications 2

B. Materials Considered 10

III. CISCO'S IOS PLATFORM 11

A. Technology Overview 11

B. The IOS CLI Computer Program 13

C. IOS's Creative CLI Commands & Hierarchies 15

D. Modes/Prompts 18

E. Screen Displays -- Responses/Outputs 21

F. IOS-XR 22

G. IOS-XE 23

H. Cisco's NX-OS Platform 23

IV. ARISTA'S EOS PLATFORM 24

A. EOS Overview 24

B. EOS CLI 28

C. EOS Program 34

V. THE COPYRIGHTED WORKS 37

A. My Understanding Of Certain Legal Principles 37

B. Ownership 39

C. Copyrightable Expressions in Cisco's CLI: Originality & Creativity 41

VI. EVIDENCE OF COPYING 59

A. Arista Had Access To Cisco's Copyrighted Works & Admitted Copying 64

B. Cisco's CLI Documentation Compared to Arista's CLI Documentation 81

C. Cisco's CLI Command Expressions Compared to Arista's CLI Command Expressions 88

D. Cisco's CLI Command Modes And Prompts Compared to Arista's Command Modes And Prompts 92

E. Cisco's CLI Command Hierarchy Compared to Arista's CLI Command Hierarchy 95

F. Cisco's CLI Command Responses Compared to Arista's CLI Command Responses 103

G. Cisco Programs Compared to the Arista Programs 116

VII. THERE IS NO INDUSTRY STANDARD FOR CISCO'S COPYRIGHTED WORKS 124

VIII. CONTRIBUTORY INFRINGEMENT & VICARIOUS LIABILITY 139

IX. CISCO'S COPYRIGHTED WORKS WERE NOT COPIED FROM STANFORD 142

X. CONCLUSION 143

Attachment	**Description**
Copying – A	Almeroth CV
Copying – B	Materials Considered

Exhibit	**Description**
Copying – 1	Evidence of Documentation Copying
Copying – 2	Evidence of Command Copying
Copying – 3	Evidence of Output Copying
Copying – 4	Evidence of Mode/Prompt Copying
Copying – 5	Evidence of Hierarchy Copying
Copying – 6	Evidence of Help Description Copying
Copying – 7	Testing Data
Copying – 8	Images

I. INTRODUCTION

1. I have been retained by counsel for Cisco Systems, Inc. ("Cisco") as an expert in this litigation to provide opinions regarding Cisco's copyrighted works and the infringement of certain Cisco copyrights by Arista Networks, Inc. ("Arista").

2. I have been retained to consult with counsel, review documents and other information, analyze certain Arista products and services, and be available to testify regarding my opinions on behalf of Cisco in connection with litigation brought by Cisco against Arista.

3. I have been asked to analyze, among other things, whether Cisco's copyrighted works are original, creative works and expressions, and whether Arista has copied Cisco's copyrighted works, as discussed below.

4. My analysis, opinions, and reasoning are detailed below and in the attached exhibits, which provide additional analysis, opinion, reasoning, and evidence, and which are incorporated here by reference as part of this report.

5. I am paid my customary rate of $600 an hour for time spent on research, report preparation, deposition and/or trial. I am reimbursed for incurred expenses. I have not received, and do not expect to receive, any additional compensation for my work on this action, and payment of my fees is in no way contingent upon the outcome of this case, the outcome of my investigation, or the opinions that I provide.

II. BACKGROUND & QUALIFICATIONS

A. Qualifications

6. In forming my opinions, I am relying on my education and experience as described below.

7. I summarize in this section my educational background, career history, publications, and other relevant qualifications.

8. I am currently a Professor in the Department of Computer Science at the University of California, Santa Barbara (UCSB). I also hold an appointment and am a founding member of the Computer Engineering (CE) Program. I am a founding member of the Media Arts and Technology (MAT) Program, and the Technology Management Program (TMP). I also served as the Associate Director of the Center for Information Technology and Society (CITS) from 1999 to 2012. I have been a faculty member at UCSB since July 1997.

9. I hold three degrees from the Georgia Institute of Technology: (1) a Bachelor of Science degree in Information and Computer Science (with minors in Economics, Technical Communication, and American Literature) earned in June, 1992; (2) a Master of Science degree in Computer Science (with specialization in Networking and Systems) earned in June, 1994; and (3) a Doctor of Philosophy (Ph.D.) degree in Computer Science (Dissertation Title: Networking and System Support for the Efficient, Scalable Delivery of Services in Interactive Multimedia Systems, minor in Telecommunications Public Policy) earned in June, 1997.

10. One of the major themes of my research has been the delivery of multimedia content and data between computing devices and users. In my research, I have looked at large-scale content delivery systems and the use of servers located in a variety of geographic locations to provide scalable delivery to hundreds, even thousands, of users simultaneously. I have also looked at smaller-scale content delivery systems in which content, including interactive communication like voice and video data, is exchanged between computers and portable computing devices. As a broad theme, my work has examined how to exchange content more efficiently across computer networks, including the devices that switch and route data

traffic. More specific topics include the scalable delivery of content to many users, mobile computing, satellite networking, delivering content to mobile devices, and network support for data delivery in wireless network.

11. Beginning in 1992, when I started graduate school, the first focus of my research was on the provision of interactive functions (VCR-style functions like pause, rewind, and fast-forward) for near video-on-demand systems in cable systems. In particular, my work explored how to aggregate requests for movies at a cable head-end, and then how to satisfy a multitude of requests using one audio/video stream broadcast to multiple receivers simultaneously. Continued evolution of this research has resulted in the development of new techniques to scalably deliver on-demand content including audio, video, web documents, and other types of data, through the Internet and over other types of networks, including over cable systems, broadband telephone lines, and satellite links.

12. An important component of my research from the very beginning has been investigating the challenges of communicating multimedia content between computers and across networks. Although the early Internet was designed mostly for text-based non-real time applications, the interest in sharing multimedia content quickly developed. Multimedia-based applications ranged from downloading content to a device to streaming multimedia content to be instantly used. One of the challenges was that multimedia content is typically larger than text-only content, but there are also opportunities to use different delivery techniques since multimedia content is more resilient to errors. I have worked on a variety of research problems and used a number of systems that were developed to deliver multimedia content to users.

13. In 1994, I began to research issues associated with the development and deployment of a one-to-many communication facility (called "multicast") in the Internet (first

deployed as the Multicast Backbone, a virtual overlay network supporting one-to-many communication). Some of my more recent research endeavors have looked at how to use the scalability offered by multicast to provide streaming media support for complex applications like distance learning, distributed collaboration, distributed games, and large-scale wireless communication. Multicast has also been used as the delivery mechanism in systems that perform local filtering (*i.e.*, sending the same content to a large number of users and allowing them to filter locally content in which they are not interested).

14. Starting in 1997, I worked on a project to integrate the streaming media capabilities of the Internet together with the interactivity of the web. I developed a project called the Interactive Multimedia Jukebox (IMJ). Users would visit a web page and select content to view. The content would then be scheduled on one of a number of channels, including delivery to students in Georgia Tech dorms delivered via the campus cable plant. The content of each channel was delivered using multicast communication.

15. In the IMJ, the number of channels varied depending on the capabilities of the server including the available bandwidth of its connection to the Internet. If one of the channels was idle, the requesting user would be able to watch their selection immediately. If all channels were streaming previously selected content, the user's selection would be queued on the channel with the shortest wait time. In the meantime, the user would see what content was currently playing on other channels, and because of the use of multicast, would be able to join one of the existing channels and watch the content at the point it was currently being transmitted.

16. The IMJ service combined the interactivity of the web with the streaming capabilities of the Internet to create a jukebox-like service. It supported true Video-on-Demand when capacity allowed, but scaled to any number of users based on queuing requested programs.

As part of the project, we obtained permission from Turner Broadcasting to transmit cartoons and other short subject content. We also attempted to connect the IMJ into the Georgia Tech campus cable television network so that students in their dorms could use the web to request content and then view that content on one of the campus's public access channels.

17. More recently, I have also studied issues concerning how users choose content, particularly when considering the price of that content. My research has examined how dynamic content pricing can be used to control system load. By raising prices when systems start to become overloaded (i.e., when all available resources are fully utilized) and reducing prices when system capacity is readily available, users' capacity to pay as well as their willingness can be used as factors in stabilizing the response time of a system. This capability is particularly useful in systems where content is downloaded or streamed to users on-demand.

18. As a parallel research theme, starting in 1997, I began researching issues related to wireless devices. In particular, I was interested in showing how to provide greater communication capability to "lightweight devices," *i.e.*, small form-factor, resource-constrained (*e.g.*, CPU, memory, networking, and power) devices.

19. Starting in 1998, I published several papers on my work to develop a flexible, lightweight, battery-aware network protocol stack. The lightweight protocols we envisioned were similar in nature to protocols like Universal Plug and Play (UPnP) and Digital Living Network Alliance (DLNA).

20. From this initial work, I have made wireless networking—including ad hoc and mesh networks and wireless devices—one of the major themes of my research. One topic includes developing applications for mobile devices, for example, virally exchanging and tracking "coupons" through "opportunistic contact" (i.e., communication with other devices

coming into communication range with a user). Other topics include building network communication among a set of mobile devices unaided by any other kind of network infrastructure. Yet another theme is monitoring wireless networks, in particular different variants of IEEE 802.11 compliant networks, to (1) understand the operation of the various protocols used in real-world deployments, (2) use these measurements to characterize use of the networks and identify protocol limitations and weaknesses, and (3) propose and evaluate solutions to these problems.

21. As an important component of my research program, I have been involved in the development of academic research into available technology in the market place. One aspect of this work is my involvement in the Internet Engineering Task Force (IETF), including many content delivery-related working groups like the Audio Video Transport (AVT) group, the MBone Deployment (MBONED) group, Source Specific Multicast (SSM) group, the Inter-Domain Multicast Routing (IDMR) group, the Reliable Multicast Transport (RMT) group, the Protocol Independent Multicast (PIM) group, etc. I have also served as a member of the Multicast Directorate (MADDOGS), which oversaw the standardization of all things related to multicast in the HEFT. Finally, I was the Chair of the Internet2 Multicast Working Group for seven years.

22. I am an author or co-author of nearly 200 technical papers, published software systems, IETF Internet Drafts and IETF Request for Comments (RFCs).

23. My involvement in the research community extends to leadership positions for several journals and conferences. I am the co-chair of the Steering Committee for the ACM Network and System Support for Digital Audio and Video (NOSSDAV) workshop and on the Steering Committees for the International Conference on Network Protocols (ICNP), ACM

Sigcomm Workshop on Challenged Networks (CHANTS), and IEEE Global Internet (GI) Symposium. I have served or am serving on the editorial boards of IEEE/ACM Transactions on Networking, IEEE Transactions on Mobile Computing, IEEE Transactions on Networks and System Management, IEEE Network, ACM Computers in Entertainment, AACE Journal of Interactive Learning Research (JILR), and ACM Computer Communications Review.

24. I have co-chaired a number of conferences and workshops including the IEEE International Conference on Network Protocols (ICNP), ACM International Conference on Next Generation Communication (CoNext), IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), International Conference on Communication Systems and Networks (COMSNETS), IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), the International Workshop On Wireless Network Measurement (WiNMee), ACM Sigcomm Workshop on Challenged Networks (CHANTS), the Network Group Communication (NGC) workshop, and the Global Internet Symposium; and I have been on the program committee of numerous conferences.

25. Furthermore, in the courses I teach, the class spends significant time covering all aspects of the Internet including each of the layers of the Open System Interconnect (OSI) protocol stack commonly used in the Internet. These layers include the physical and data link layers and their handling of signal modulation, error control, and data transmission. I also teach DOCSIS, DSL, and other standardized protocols for communicating across a variety of physical media including cable systems, telephone lines, wireless, and high-speed Local Area Networks (LANs).

26. I teach the configuration and operation of switches, routers, and gateways including routing and forwarding and the numerous respective protocols as they are standardized

and used throughout the Internet. Topics include a wide variety of standardized Internet protocols at the Network Layer (Layer 3), Transport Layer (Layer 4), and above.

27. In addition to having co-founded a technology company myself, I have worked for, consulted with, and collaborated with various technology companies.

28. I am a Member of the Association of Computing Machinery (ACM) and a Fellow of the Institute of Electrical and Electronics Engineers (IEEE).

29. In my 35 years of experience with computer software, I have reviewed innumerable lines of source code written by many different programmers. And as mentioned above, I also teach the configuration and operation of various network devices (switches, routers, gateways), which includes topics related to command line interface computer programs and the technology upon which such programs are based. I also teach network programming classes and assign programming projects that I personally review and grade.

30. As a result of my teaching, I am familiar with variations of command and program expression that arise when a set of engineers and/or programmers are asked to solve a problem. What I have found in my decades of experience is that engineers and programmers find many ways to write commands and programs to express solutions to the same problem.

31. I also am familiar with tools used to assist in the detection of plagiarism or source code copying in a university setting. I have worked with UCSB to develop software tools for detecting plagiarism. For example, I was involved in developed the PAIRwise Plagiarism Detection Systems ("PAIRwise"). PAIRwise is a service that I helped invent that provides a variety of functions including comparing assignments against other assignments in a class and comparing assignments against the vast amount of data available on the Internet. The goal is to help professors detect plagiarism in their students' work.

32. I also have conducted research; co-authored papers; and developed systems to support the detection of plagiarism through document comparison and similarity detection (*see, e.g.*, the papers and systems in my CV, specifically II.A.55, II.A.40, II.B.36, and II.E.15). I have also used tools like CopyFind, PAIRwise, and the Measure of Software Similarity (MOSS) program in my courses.

33. Furthermore, I find programming an expressive, creative endeavor, just like technical writing. In both cases, although there is a purpose to be served, there are many ways to accomplish the goal, and a wide range of expressive choices in doing so.

34. I attach as **Attachment A** my *curriculum vitae*¸ which includes a more complete list of my qualifications.

B. Materials Considered

35. In forming my opinions, I have relied on my education and experience as described above.

36. I have also reviewed and considered the materials cited in this reports as well as the materials listed in **Attachment B** of this report, and the materials cited in all exhibits to this report, all of which are incorporated here by reference.

37. I also have inspected and/or tested:

- three Arista switches running EOS
- Arista's EOS operating system produced by Arista in this litigation
- Arista's EOS source code made available for inspection at the office of Arista's counsel
- two Cisco switches running IOS (Catalyst 3560E, Catalyst 4948E)
- Cisco source code produced by Cisco in this litigation

- Source code relating to Stanford's development of different technology

38. In addition to the materials specifically identified, I may provide further exhibits to be used as a summary of or support for my opinions.

39. I expect to testify at trial regarding the matters addressed in this report and any supplemental or amended report I may submit. I also expect to testify at trial with respect to matters addressed by experts testifying on behalf of Arista. I also may testify on other matters relevant to this case, if asked by the Court or by the parties' counsel.

III. CISCO'S IOS PLATFORM

A. Technology Overview

40. The products involved in this case are network devices (routers and switches) and their operating systems and command line interface computer programs, including display inputs and outputs ("CLI"). Network devices are, at a high level, electronic devices that connect or create connections between one computer network and another and allow information to be transmitted among networks locally, regionally, nationally, and internationally. Network devices, for example, form the structural backbone of the Internet. They move or "forward" packets of data from the sender's location to the recipient's location along network pathways that can span the world. Individually, they determine the next hop towards a destination. Collectively, they determine the route that packets will take from a source to a destination. The science of routing and switching data through the Internet is complex and challenging because messages must be sent quickly, securely, and accurately; it is a science that is instrumental to the viability of the Internet and worldwide commerce.

41. Cisco has been the recognized world leader in internetworking technology since early in its history, including approximately when it began selling routers in the mid-1980s.

42. At the heart of each Cisco router and switch is Cisco's proprietary operating system, called the Cisco Internetworking Operating System ("IOS"). IOS is a complex computer program that controls a router/switch. According to Cisco, IOS is one of its "core technolog[ies]"[1] and that it is one of the company's most valuable assets—a "critical component of Cisco's business."[2]

43. Originally developed in the 1980s, IOS has undergone continual enhancement over the years, and I understand Cisco has invested hundreds of millions of dollars developing IOS.[3] Since the introduction of IOS in the mid-1980s, Cisco continuously has upgraded, tested, and improved IOS through multiple releases. For example, IOS today operates on numerous Cisco routers as well as many of Cisco's other network products such as switches and gateways.[4]

44. As a software architecture, IOS provides the unifying principles around which an internetwork can be maintained cost-effectively over time. It can be upgraded to adapt to changing technologies (hardware and software) as they evolve and are improved. IOS can be thought of as an internetworking brain, a highly intelligent administrative unit that manages and controls complex, distributed network resources, and functions.

45. Since its release in the mid-1980s, IOS has undergone continual enhancement over the years, and Cisco developed specific and novel solutions in a number of protocol areas. These solutions are embodied in at least its programs.

46. Cisco protects its IOS source code and does not disclose it publicly.

---

[1] CSI-CLEO3838924, Exhibit 2 to Cisco's Motion for Preliminary Injunction, *Cisco Systems v. Huawei* ("Cisco's PI Motion"), Declaration of Charles Giancarlo ("Giancarlo Decl."), ¶ 7.

[2] *Id.* at ¶12.

[3] *Id.*

[4] *See id.*, ¶¶ 3, 5.

47. I have personally inspected portions of the IOS source code in support of preparing this report.

B. The IOS CLI Computer Program

48. In networking systems before IOS, complete configuration files were loaded on network devices using remote servers. In these older system, errors in the configuration files often would not be noticed until the router was activated. What this meant was that a new configuration file was needed to correct any error that may have been included in an initial configuration file. This process was a slow and inefficient way of configuring network devices.

49. In the mid-1980s, Cisco endeavored to solve this problem.[5] Cisco's engineering team—lead by Kirk Lougheed—came up with the idea to create a unique CLI computer program.[6] This decision was an important one. As is the case with personal computers and workstations, the user interface computer program for a network device is a critical component of the system—it is the portal by which the user interacts with the device. It gives the operating system its distinct character, and distinguishes it from other operating systems.

50. The computer program that Mr. Lougheed and his fellow Cisco engineers chose to build was one that would enable configuration changes directly on a Cisco router.[7] A CLI computer program allows a user to enter a "command" into a text-based input system in order to provide information (*e.g.*, a status request or a configuration command) to, and receive

---

[5] *See generally* Deposition transcripts of Kirk Lougheed; Conversation with Kirk Lougheed (June 3, 2016).

[6] *See generally* Deposition transcripts of Kirk Lougheed; Conversation with Kirk Lougheed (June 3, 2016).

[7] Conversation with Kirk Lougheed (June 3, 2016); *see generally* Deposition Testimony of Kirk Lougheed; Abhay Roy; Adam Sweeney; Anthony Li; Devadas Patil; Greg Satz; Hugh Holbrook; Phillip Remaker; Ramanthan Kavasseri; and Tong Liu; *see also infra* Section V(C) (discussing creativity and originality).

information from, the device. When a user enters a command, the device typically provides some type of feedback to the user, for example, command confirmation or the output of executing such a command.

51. In choosing to develop a CLI computer program (as opposed to other alternatives, *e.g.*, a graphical user interface), the Cisco engineers faced endless aesthetic choices for each of the numerous commands now found in the Cisco IOS CLI computer program and to select an elaborate structure and organization for these commands.[8] Neither the commands nor the structure and organization of the commands were dictated by technical requirements—they could have comprised different letters or numbers and have been organized in various different number of ways.[9] Additionally, Cisco designed expressive textual outputs that are used by the CLI computer program when providing feedback to the user and created an extensive set of command definitions as part of the program's help system. Like the initial choice of a CLI computer program, each of these subsequent steps in the development of the program was guided by the creativity and personal preferences of Cisco's engineers.[10]

52. The Cisco IOS CLI is the product of decades of investment and creative endeavor by Cisco. Cisco also has spent years developing comprehensive user documentation and user

[8] Conversation with Kirk Lougheed (June 3, 2016); *see generally* Deposition Testimony of Kirk Lougheed; Abhay Roy; Adam Sweeney; Anthony Li; Devadas Patil; Greg Satz; Hugh Holbrook; Phillip Remaker; Ramanthan Kavasseri; and Tong Liu; *see also infra* Section V(C) (discussing creativity and originality).

[9] Conversation with Kirk Lougheed (June 3, 2016); *see generally* Deposition Testimony of Kirk Lougheed; Abhay Roy; Adam Sweeney; Anthony Li; Devadas Patil; Greg Satz; Hugh Holbrook; Phillip Remaker; Ramanthan Kavasseri; and Tong Liu; *see also infra* Section V(C) (discussing creativity and originality).

[10] *See generally* Deposition transcripts of Kirk Lougheed; Conversation with Kirk Lougheed (June 3, 2016); *see generally* Deposition Testimony of Kirk Lougheed; Abhay Roy; Adam Sweeney; Anthony Li; Devadas Patil; Greg Satz; Hugh Holbrook; Phillip Remaker; Ramanthan Kavasseri; and Tong Liu; *see also infra* Section V(C) (discussing creativity and originality).

manuals to further educate and train customers on the use of IOS and its CLI.[11] As a result of this hard work and investment, I understand Cisco believes that its CLI also is a valuable asset and critical component of its business.[12]

C. IOS's Creative CLI Commands & Hierarchies

53. As part of its CLI development, Cisco developed a distinctive and elegant syntax and structure for the commands that are used by the IOS CLI. As the IOS documentation explains:[13]

> **Understanding Command Syntax**
>
> Command syntax is the format in which a command should be entered in the CLI. Commands include the name of the command, keywords, and arguments. Keywords are alphanumeric strings that are used literally. Arguments are placeholders for values that a user must supply. Keywords and arguments may be required or optional.
>
> Specific conventions convey information about syntax and command elements. Table 5 describes these conventions.

[11] CSI-CLEO3838924, Giancarlo Decl., ¶ 12.

[12] CSI-CLEO3838924, Giancarlo Decl., ¶ 12.

[13] CSI-CLI-00226710 at CSI-CLI-00226747-48.

Table 5 CLI Syntax Conventions

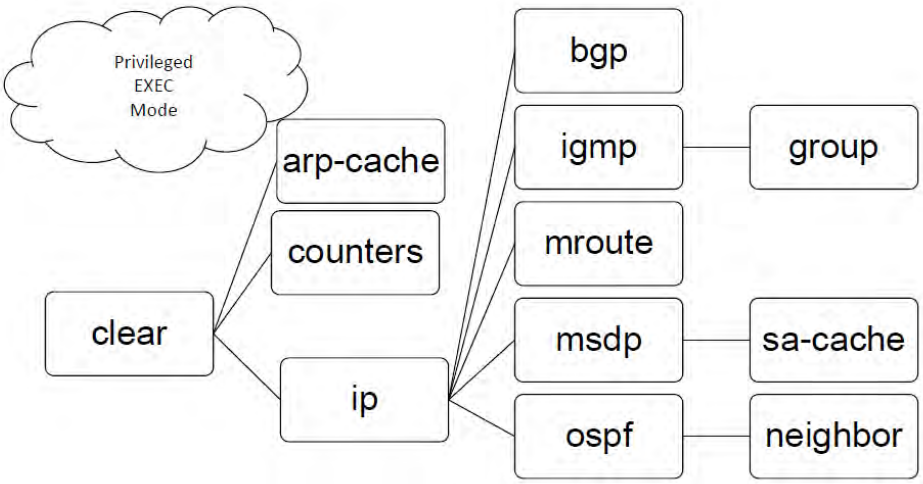
Symbol/Text	Function	Notes
< > (angle brackets)	Indicate that the option is an argument.	Sometimes arguments are displayed without angle brackets.
A.B.C.D.	Indicates that you must enter a dotted decimal IP address.	Angle brackets (< >) are not always used to indicate that an IP address is an argument.
WORD (all capital letters)	Indicates that you must enter one word.	Angle brackets (< >) are not always used to indicate that a WORD is an argument.
LINE (all capital letters)	Indicates that you must enter more than one word.	Angle brackets (< >) are not always used to indicate that a LINE is an argument.
<cr> (carriage return)	Indicates the end of the list of available keywords and arguments, and also indicates when keywords and arguments are optional. When <cr> is the only option, you have reached the end of the branch or the end of the command if the command has only one branch.	—

54. Cisco's command expressions are organized hierarchically into groups and sub-groups of command expressions (as opposed to, for instance, having no organizational structure). For example, I understand Cisco has asserted various command hierarchies in this case including, *e.g.*, the "aaa" command hierarchy, "bgp" command hierarchy, "clear" command hierarchy, "dot1x" command hierarchy, "ip" command hierarchy, "ipv6" command hierarchy, "neighbor" command hierarchy, "show" command hierarchy, "snmp-server" command hierarchy, "spanning-tree" command hierarchy, "vrrp" command hierarchy, among other command expressions and hierarchies.

55. Within a given command hierarchy, all of the commands start with the same word. For example, all of the commands within the "aaa" command hierarchy start with the "aaa." Additional sub-hierarchies within a command hierarchy that Cisco has asserted in this case include, *e.g.*, "ip dhcp" subhierarchy, "ip igmp" sub-hierarchy, "ip msdp" sub-hierarchy, "ip

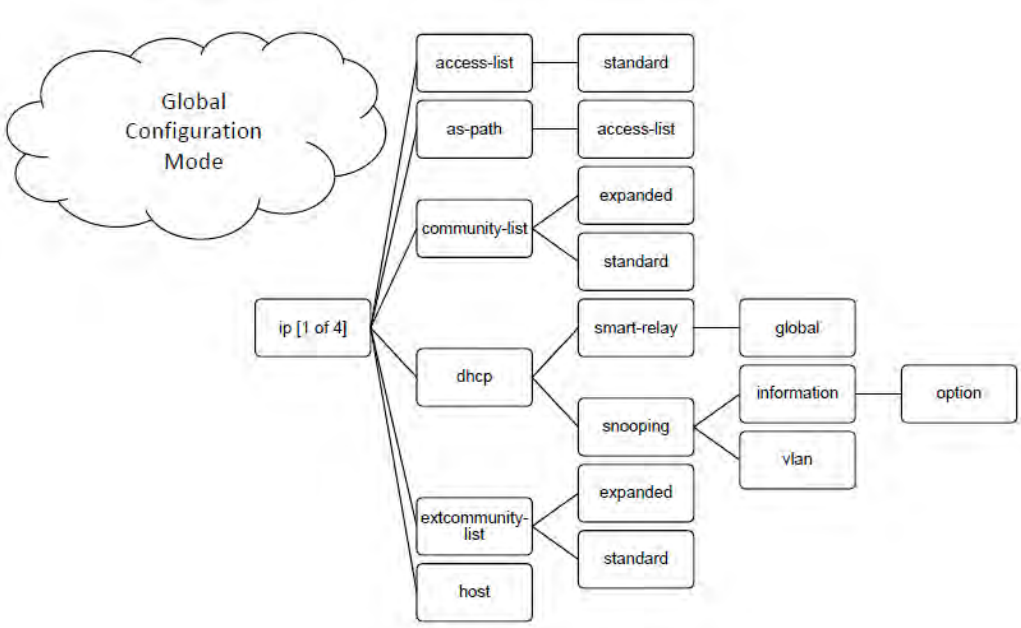
ospf" sub-hierarchy, "ip pim" sub-hierarchy, "ipv6 nd" sub-hierarchy, "ipv6 ospf" sub-hierarchy, "show interfaces" subhierarchy, and "show ipv6" sub-hierarchy.

56. Within a given command sub-hierarchy, all of the commands start with the same two words. For example, all of the commands within the "ip dhcp" sub-hierarchy start with "ip dhcp." And there can be further sub-hierarchies within a given sub-hierarchy. One way to visually illustrate the hierarchy and organization of Cisco's command expressions is through the use of a tree structure, for example:[14]



("clear" hierarchy in "Privileged EXEC" mode in IOS 11.0)

[14] *See* Exhibit D to Cisco's Responses to Arista Interrogatory Nos. 2 and 16. The images below were taken from Cisco's interrogatory response, and I agree with Cisco's depiction of these hierarchies.



("ip" hierarchy in "Global Configuration" model in NX-OS 6.2)

57. I understand this hierarchical arrangement of Cisco's CLI command expressions was originally created by Cisco engineer Kirk Lougheed in 1986.[15] That arrangement was first documented in the "Cisco Systems ASM/AGS User Manual and Configuration Guide Version 5.2."[16] As command expressions were added in subsequent versions of Cisco's copyrighted operating systems, the hierarchical arrangement of command expressions was modified and extended by the addition of more expressions.[17]

D. Modes/Prompts

58. In the IOS CLI, command "modes" are used to navigate the CLI and perform basic device startup, configuration, and monitoring tasks. "The CLI command mode structure is

[15] Cisco's Third Supplemental Response to Arista's Interrogatory No. 16; Conversation with Kirk Lougheed (June 3, 2016); *see generally* Deposition Testimony of Kirk Lougheed.

[16] CSI-CLI-00358622 to CSI-CLI-00358654.

[17] Cisco's Third Supplemental Response to Arista's Interrogatory No. 16.

hierarchical, and each mode supports a specific set of commands."[18] Each mode also has an associated visual "prompt" that helps the user identify which mode they are in and, therefore, which commands are available.[19] Not unlike multi-word command expressions, creating the precise modes and their associated prompts associated with IOS was done through a creative process since professional judgment and subjective decisions by Cisco's engineers were required to create them. The IOS command modes and their associated prompts are discussed below.

59. "User EXEC Mode" is the default command mode for the CLI. The EXEC commands available at the user EXEC level are a subset of those available at the "privileged EXEC" mode. In general, the user EXEC commands allow a user to connect to remote devices, change terminal settings on a temporary basis, perform basic tests, and list system information. The prompt for user EXEC mode is the name of the device followed by an angle bracket, e.g., Router>.

60. Another example of an IOS mode is "Privileged EXEC Mode." Privileged EXEC mode is password protected, and allows the use of all EXEC mode commands available on the device. To enter privileged EXEC mode from user EXEC mode, a user will enter the "enable" command. The privileged EXEC mode prompt consists of the devices' host name followed by the pound sign, *e.g.*, Router#.

61. A third type of IOS mode is "Global Configuration Mode." "Global Configuration Mode" is used for configuration commands that generally apply to features that affect a system as a whole, rather than just one protocol or program. Once a user is in Privileged EXEC mode they can access "Global Configuration Mode" through the use of the "enable"

[18] CSI-CLI-00226710 at CSI-CLI-00226743.

[19] CSI-CLI-00226710 at CSI-CLI-00226745.

command. The router prompt for global configuration mode is indicated by the term config in parenthesis: Router(config)#.

62. IOS prompts help a user identify which mode they are in and, therefore, which commands are available for use. Each mode described above has the following corresponding prompts:[20]

Table 3 CLI Command Modes

Command Mode	Access Method	Prompt	Exit Method	Mode Usage
User EXEC	Log in.	`Router>`	Issue the **logout** or **exit** command.	• Change terminal settings. • Perform basic tests. • Display device status.
Privileged EXEC	From user EXEC mode, issue the **enable** command.	`Router#`	Issue the **disable** command or the **exit** command to return to user EXEC mode.	• Issue **show** and **debug** commands. • Copy images to the device. • Reload the device. • Manage device configuration files. • Manage device file systems.
Global configuration	From privileged EXEC mode, issue the **configure terminal** command.	`Router(config)#`	Issue the **exit** command or the **end** command to return to privileged EXEC mode.	Configure the device.
Interface configuration	From global configuration mode, issue the **interface** command.	`Router(config-if)#`	Issue the **exit** command to return to global configuration mode or the **end** command to return to privileged EXEC mode.	Configure individual interfaces.
Line configuration	From global configuration mode, issue the **line vty** or **line console** command.	`Router(config-line)#`	Issue the **exit** command to return to global configuration mode or the **end** command to return to privileged EXEC mode.	Configure individual terminal lines.

63. The command modes and prompts were first documented in the "Cisco Systems ASM/AGS User Manual and Configuration Guide Version 5.2."[21] I understand that they were created by at least the date of that document: July 20, 1986.[22]

[20] CSI-CLI-00226710 at CSI-CLI-00226745.

E. Screen Displays -- Responses/Outputs

64. Another aspect of Cisco's CLI are the screen outputs/displays generated by the CLI in response to a command input. Cisco's CLI outputs contain context sensitive response information that is displayed to a user, such as configuration information of the device and networking information related to a device, among other command-specific outputs. The CLI outputs contain unique and varied information types in textual form and are organized in unique structural arrangements, all of which were created by Cisco. Exemplary CLI outputs for certain asserted Cisco CLI commands are provided below as examples:

```
Router# show ip route

Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
```

(output for "show ip route"[23])

```
Router# show interfaces atm 0/0/0
ATM0/0/0 is up, line protocol is up
 Hardware is cyBus ATM
 Internet address is 10.1.1.1/24
 MTU 4470 bytes, sub MTU 4470, BW 156250 Kbit, DLY 80 usec, rely 255/255, load 1/255
 Encapsulation ATM, loopback not set, keepalive set (10 sec)
 Encapsulation(s): AAL5, PVC mode
 256 TX buffers, 256 RX buffers,
 2048 maximum active VCs, 1024 VCs per VP, 1 current VCCs
 VC idle disconnect time: 300 seconds
 Last input never, output 00:00:05, output hang never
 Last clearing of "show interface" counters never
 Queueing strategy: fifo
 Output queue 0/40, 0 drops; input queue 0/75, 0 drops
 5 minute input rate 0 bits/sec, 1 packets/sec
 5 minute output rate 0 bits/sec, 1 packets/sec
     5 packets input, 560 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     5 packets output, 560 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
```

---

[21] CSI-CLI-00358622 to CSI-CLI-00358654.

[22] Cisco's Third Supplemental Response to Arista's Interrogatory No. 16.

[23] CSI-CLI-00408381, Cisco IOS IP Routing Protocols Command Reference, Release 12.4 (2005), at IP2R-553.

(output for "show ip route"[24])

```
Spanning tree enabled protocol rstp
Root ID     Priority    32770
            Address     000d.eca3.9f01
            Cost        4
            Port        4105 (port-channel10)
            Hello Time  2  sec  Max Age 20 sec  Forward Delay 15 sec

Bridge ID   Priority    32770  (priority 32768 sys-id-ext 2)
            Address     0022.5579.7641
            Hello Time  2  sec  Max Age 20 sec  Forward Delay 15 sec

Interface        Role Sts Cost      Prio.Nbr Type
---------------- ---- --- --------- -------- --------------------------------
Po10             Root FWD 2         128.4105 (vPC peer-link) P2p
Po20             Desg FWD 1         128.4115 (vPC) P2p
Po30             Root FWD 1         128.4125 (vPC) P2p
```

(output for "spanning tree enabled protocol rstp"[25])

65. CLI screen outputs are a key part of the IOS CLI "look and feel" as they are the expressions that a user (typically a network engineer) interacts with and is able to respond to. And it is one of the distinct ways that a user knows that he or she is using Cisco's IOS CLI. As with the command inputs, the Cisco engineers faced endless aesthetic choices for each of the numerous screen outputs now found in the Cisco IOS CLI computer program. The structure and organization of the screen outputs were not dictated by technical requirements—they could be been organized in various different number of ways.

F. IOS-XR

66. IOS XR is a series of Cisco IOS versions used on carrier-grade routers such as the CRS series, 12000 series, and ASR9000 series. IOS-XR was designed to service the needs of

[24] CSI-CLI-00248571, Cisco IOS Asynchronous Transfer Mode Command Reference (2011), at 476.

[25] CSI-CLI-00178252, Cisco Nexus 7000 Series NX-OS Layer 2 Switching Command Reference (2013), at 63.

service providers. IOS-XR was created by engineers and uses a similar CLI to the traditional IOS CLI discussed above.[26]

G. IOS-XE

67. IOS-XE is another Cisco operating system and is related to traditional IOS. IOS-XE was built on a modular operating system and it provides scale and serviceability for both enterprises and service providers. IOS-XE supports the complete set of Cisco IOS features including the IOS CLI discussed above. IOS-XE also scales advanced service delivery without impacting system performance, integrates applications in the network, improves security, reliability, and simplicity, facilitates programmability for cloud service orchestration, supports next-generation platform, among other features.[27]

H. Cisco's NX-OS Platform

68. NX-OS is Cisco's next generation operating system. NX-OS was created for Cisco's Nexus platform and was built primarily for data center environments. Cisco NX-OS provides a CLI as well as implementations of relevant networking standards and a variety of data center related features. Cisco NX-OS runs on the Cisco Nexus Family of hardware-based network switches, which include Cisco Nexus 7000, 5000, 4000, and 1000V Series Switches and

[26] *See generally* http://www.cisco.com/c/en/us/products/ios-nx-os-software/ios-xr-software/index.html?CAMPAIGN=Cisc_3; *see also, e.g.*, Cisco copyrighted documentation submitted with the Copyright Office for this operating system as set forth in Cisco's responses to Interrogatory Nos. 24 and 25, which are incorporated here by reference.

[27] *See generally* http://www.cisco.com/c/en/us/products/ios-nx-os-software/ios-xe/index.html; Cisco copyrighted documentation submitted with the Copyright Office for this operating system as set forth in Cisco's responses to Interrogatory Nos. 24 and 25, which are incorporated here by reference.

Cisco Nexus 2000 Series Fabric Extenders; Cisco MDS 9000 Family storage switches; and Cisco UCS 6100 Series Fabric Interconnects.[28]

IV. ARISTA'S EOS PLATFORM

A. EOS Overview

69. Founded in 2004 by former Cisco engineers, Arista Networks ("Arista") is one of Cisco's competitors in the internetworking industry. According to Arista's CEO—a former Cisco executive—Cisco is viewed by Arista as a "fierce competitor."[29] Like Cisco, Arista sells switches with an operating system and command line interface computer program, referred to by Arista as the Extensible Operating System ("EOS"). According to Arista, its EOS "is the core of Arista cloud networking solutions for next-generation data centers and cloud networks."[30] The switches that Arista's sells with its EOS and CLI are based on 10GbE, 40GbE, and 100GbE platforms, and include at least its 7010T, 7280SE, 7150S, 7050TX, 7050SC, 7050OX, 7250OX, 7060CX, 7260X, 7300 series, and 7500R series switches.

70. As the evidence below shows, Arista's purpose in creating EOS was to create a substitute for Cisco's IOS. EOS directly competes with IOS in the market such that if a competitor has an Arista switch running EOS they have no need for Cisco switches running IOS (or one of Cisco's other copyrighted operating systems).

---

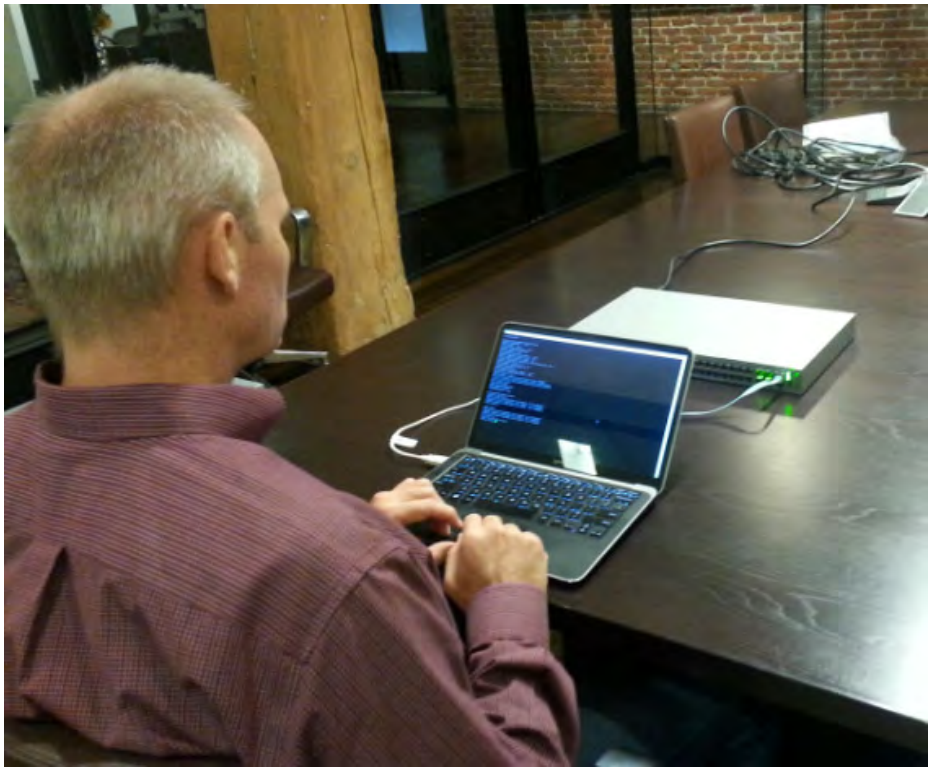
[28] *See* http://www.cisco.com/c/en/us/products/collateral/ios-nx-os-software/nx-os-software/data_sheet_c78-652063.pdf; Cisco copyrighted documentation submitted with the Copyright Office for this operating system as set forth in Cisco's responses to Interrogatory Nos. 24 and 25, which are incorporated here by reference.

[29] CSI-CLl-00357842 at CSI-CLI-00357851.

[30] *See* https://www.arista.com/en/products/eos.

71. In support of my opinions, and during the process of preparing this report, I personally inspected and tested three different Arista switches running EOS, pictures of which I have provided along with this report. I have reproduced some images of the Arista switches I inspected and tested below as examples:

(Arista 7010T-48)



(testing an Arista 7010T-48 running EOS)

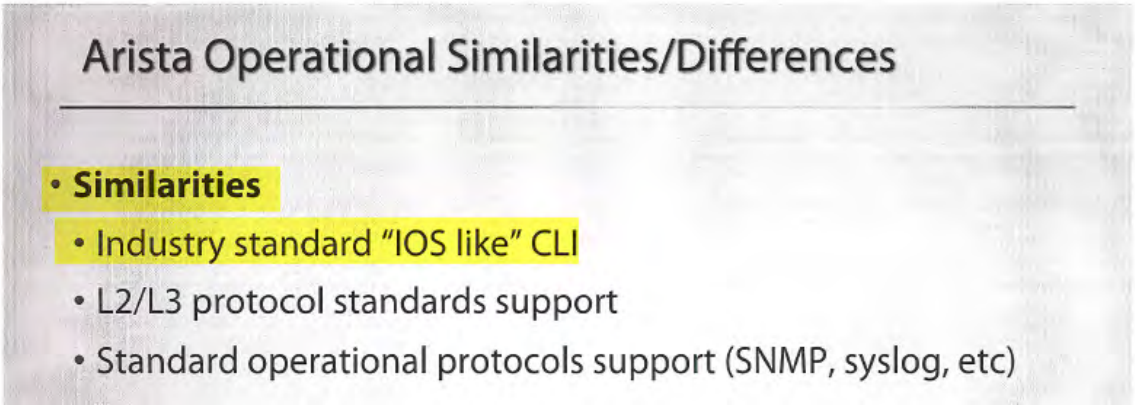
(Arista DCS-7554)

(testing an Arista DCS-7554 running EOS)

B. EOS CLI

72. Like Cisco's IOS, Arista's EOS has a CLI that network engineers and other users can leverage to configure Arista switches. Arista promotes its EOS CLI as being similar to Cisco's IOS or "IOS like":[31]

[31] Sadana Deposition, Exhibit 382, at 78.



73. According to Arista, the EOS CLI is a "familiar industry standard CLI and runs a single binary software image across the Arista switching family."[32] Based on the evidence that I have reviewed in this case, Arista's use of the term "industry standard" is effectively a codename that Arista has used to refer to Cisco's IOS CLI. As described in more detail below, there is no CLI industry standard let alone an industry standard for Cisco's copyrighted works, which include elements such as screen displays, outputs, and prompts. Indeed, as one Arista employee wrote: "Juniper's JunOS is different enough from 'industry standard' (meaning: whatever Cisco did) . . . ."[33]

74. Another Arista engineer, Lincoln Dale, gave a presentation at a QuestNet Conference in July 2013 where he told the audience that Arista's use of the term "industry standard" was Arista's internal way of referring to Cisco's IOS: "We say that our switches run an industry standard CLI. I guess that's my joke for saying it's the same as IOS." Arista's use of the term "industry standard" as a codename for Cisco's IOS CLI is further confirmed by [redacted]

[32] ANI-ITC-944_945-3473603.

[33] ARISTANDCA1195413 (emphasis added).

[redacted]

In other words, the EOS CLI is marketed as being familiar because it was modeled after Cisco's IOS CLI, which was the industry leading CLI on the market at the time that Arista developed its EOS CLI.

75. As Arista's own executives and engineers also have explained to the public, the EOS CLI was intentionally designed to be similar to Cisco's IOS CLI:

- "[A] Cisco CCIE expert would be able to use Arista right away, because we have a similar command-line interface and operational look and feel. Where we don't have to invent, we don't."[35]

- Arista tried to "[p]rovide familiar interfaces to ease adoption" including a "standard CLI that … retains familiar management commands" such that "80% [of Arista customers] tell [Arista] they appreciate the way they can leverage their deep [Cisco] IOS experience, as they can easily upgrade an aging [Cisco] Catalyst infrastructure to Arista."[36]

- "Familiar management interfaces, standard CLI … It's been very helpful for our customers to be able to rapidly adopt our products and integrate them into their environments … that our switches provide a familiar management interface so their existing tools and processes, screen scraping, automation, continue to work just as they did before."[37]

76. Many other examples of Arista employees confirming that the EOS CLI was designed to be similar to Cisco's IOS CLI are discussed below.[38]

---

[34] ANI-ITC-944_94 0962624 at ANI-ITC-944_945-0962625.

[35] CSI-ANI-00381280, John Gallant, "How Arista Networks Got Out In Front of the SDN Craze," Network World (Feb. 22, 2013).

[36] Posting of Kenneth Duda to Arista EOS Central, "Linux as a Switch Operating System: Five Lessons Learned" (Nov. 5, 2013), *available at*https://eos.arista.com/linux-as-a-switch-operating-system-five-lessons-learned/.

[37] Arista, *EOS Bits & Bytes - Episode 1 - Lessons Learned While Building a Network OS on Top of Linux*, Arista EOS Central - Video Library (Jan. 30, 2014), at 6:55–7:56, *available at* http://eos.arista.com/wpcontent/themes/aristaeos/video-lightbox.php?vid=ttp6lavHKGo.

[38] *See infra* Section VI(A).

77. Like Cisco, Arista has documentation related to its EOS platform as well as the EOS CLI.[39] Arista's documentation describes the command syntax, structure, modes, prompts, and related information sufficient to teach a user how to operate Arista's EOS CLI.[40]

78. Unlike Cisco, however, Arista did not always have its own documentation. [redacted]

79. Also in 2010, Arista executive Anshul Sadana [redacted]

[39] *See generally* CSI-CLI-00007473,CSI-CLI-00007244, CSI-CLI-00006858, CSI-CLI-00007841, CSI-CLI-00010517, CSI-CLI-00008985, CSI-CLI-00014141, CSI-CLI-00011973, CSI-CLI-00018146, CSI-CLI-00000084, CSI-CLI-00004616, CSI-CLI-00020575, CSI-CLI-00002332, CSI-CLI-00016001.

[40] *Id.*

[41] *See infra* Sections VI(A), VIII.

[42] ARISTANDCA1199299.

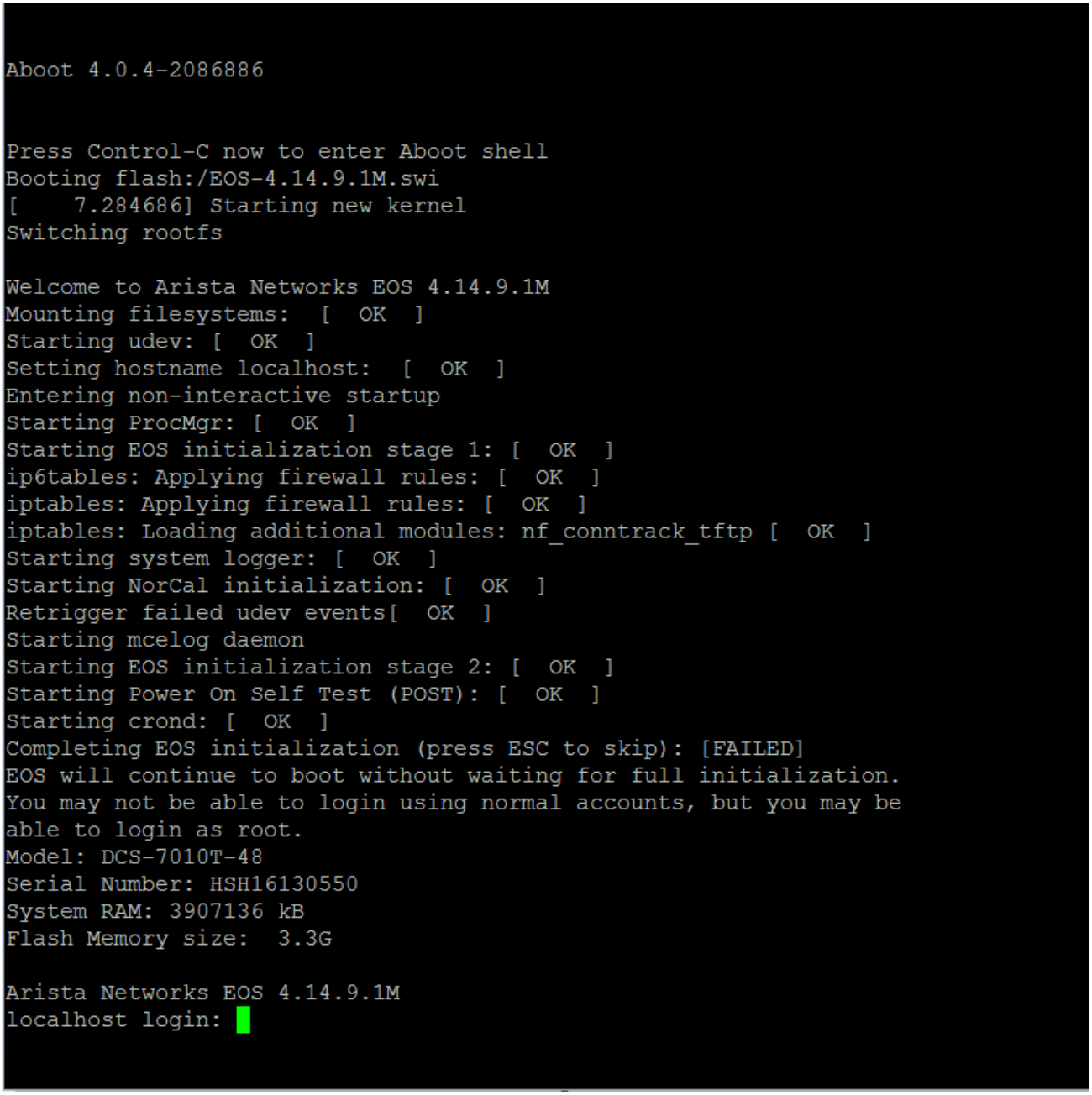
[43] ARISTANDCA1199299.

[redacted]

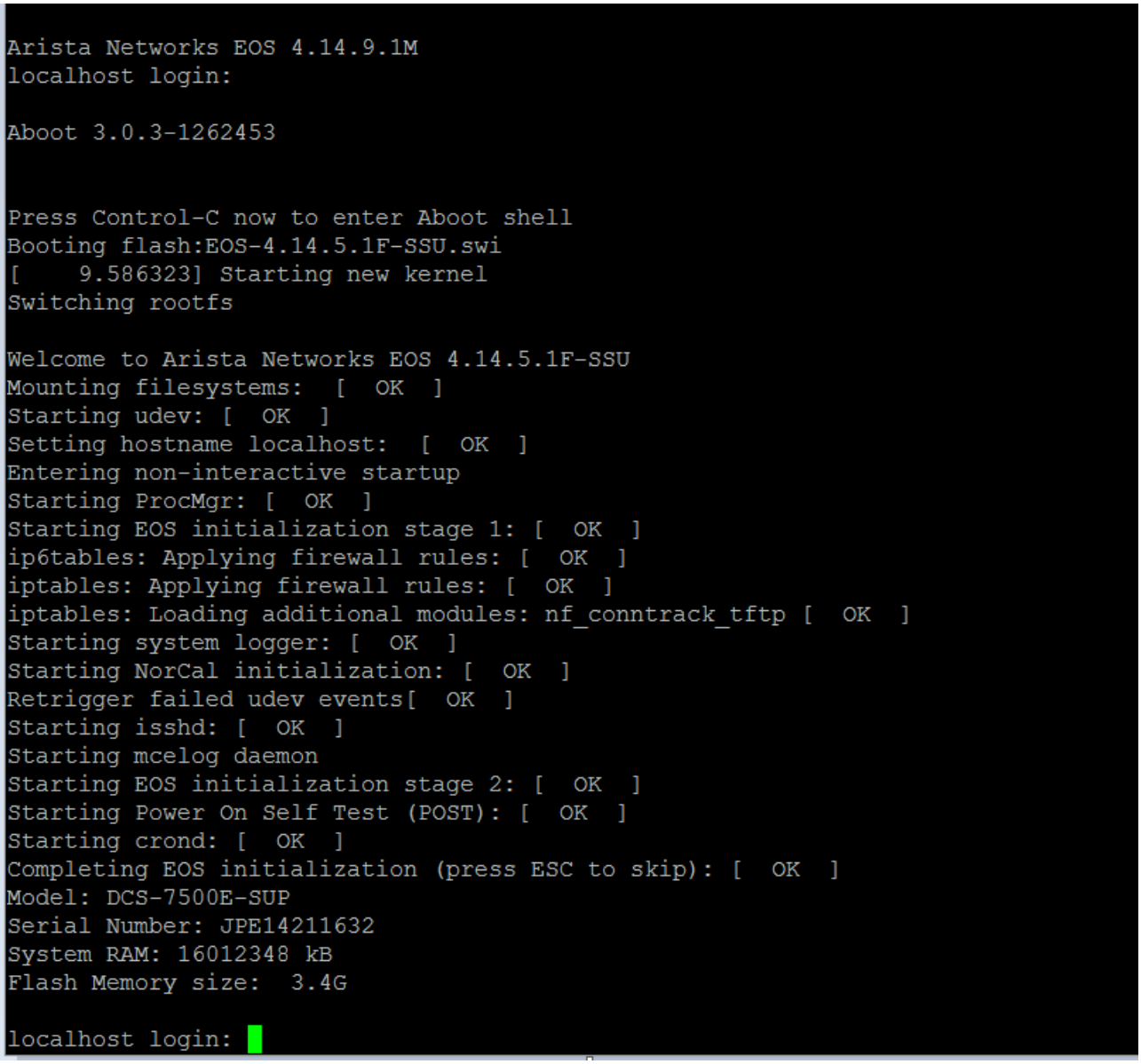
[redacted]

80. As part of preparing this report, I also performed extensive testing on Arista's EOS CLI. I have provided exemplary images of a computer screen showing the CLI display that an Arista customer would see when it logs into an Arista switch running EOS:

[44] ANI-ITC-944_945-3473603.



(Arista 7010T-48 running EOS 4.14.9.1M)



(Arista DCS-7554 running EOS 4.14.5.1F-SSU)

C. EOS Program

81. In order to understand and analyze Arista's EOS, I have reviewed its programs on numerous occasions.

82. Arista's EOS program provides the EOS CLI and contains specific programs and functions. For example, EOS includes programs to generate a command line interface and

command line into which commands can be entered (as shown above). EOS (like Cisco's IOS) is able to execute entered commands (including the 500+ multi-word command expressions asserted in this case) within the construct of specific hierarchical modes and sub-modes,[45] as explained in Arista's user manuals and guides as well:[46]

3.4 Command Modes

Command modes define the user interface state. Each mode is associated with commands that perform a specific set of network configuration and monitoring tasks.

- Section 3.4.1: Mode Types lists the available modes.
- Section 3.4.2: Navigating Through Command Modes lists mode entry and exit commands.
- Section 3.4.3: Command Mode Hierarchy describes the mode structure.
- Section 3.4.4: Group-Change Configuration Modes describes editing aspects of these modes.

3.4.1 Mode Types

The switch includes these command modes:

- **EXEC**: EXEC mode commands display system information, perform basic tests, connect to remote devices, and change terminal settings. When logging into EOS, you enter EXEC mode.

  EXEC mode prompt: `switch>`

- **Privileged EXEC**: Privileged EXEC mode commands configure operating and global parameters. The list of Privileged EXEC commands is a superset of the EXEC command set. You can configure EOS to require password access to enter Privileged EXEC from EXEC mode.

  Privileged EXEC mode prompt: `switch#`

- **Global Configuration**: Global Configuration mode commands configure features that affect the entire system, such as system time or the switch name.

  Global Configuration mode prompt: `switch(config)#`

- **Interface Configuration**: Interface configuration mode commands configure or enable Ethernet, VLAN, and Port-Channel interface features.

  Interface Configuration mode prompt: `switch(config-if-Et24)#`

- *Protocol specific mode*: Protocol specific mode commands modify global protocol settings. Protocol specific mode examples include **ACL Configuration** and **Router BGP Configuration**.

  The prompt indicates the active command mode. For example, the Router BGP command prompt is `switch(config-router-bgp)#`

[redacted]

[45] Mode Hierarchy: Mode CliParser.py > ConfigModeBase BasicCli.py > GlobalConfigMode BasicCli.py.

[46] CSI-CLI-00016001 at CSI-CLI-00016113; *see also* ANI-ITC-944 _ 945-0962624 at ANI-ITC-944 945-0962628 ("Multiple levels of modes are OK, too. Our support for these is improving, and they help to identify the objects being configured in the naturally nested structure of many configuration models.").

[redacted]

[redacted]

87. As explained below, Arista's EOS also includes hundreds of textual similarities as compared to Cisco's IOS, including hundreds of command descriptions.

V. THE COPYRIGHTED WORKS

A. My Understanding Of Certain Legal Principles

88. I have been informed that under the law, a copyright owner has the exclusive right to do and to authorize others to reproduce, prepare derivative works from, distribute, publicly perform, or publicly display, the copyrighted work. I understand that the term derivative work refers to a work based on one or more preexisting works, including a work in which the preexisting work or works is/are recast, transformed, or adapted.

89. It is my understanding that to establish direct copyright infringement, a plaintiff must prove that the plaintiff is the owner of the copyright and that the defendant copied elements of the copyrighted work.

90. I understand that one way to prove that the defendant copied the plaintiff's work, the plaintiff may show that the defendant had access to the plaintiff's copyrighted work and that there are similarities between the defendant's work and the plaintiff's work.

91. I further understand that in assessing similarity, courts consider both quantitative similarity—how much was copied—as well as qualitative similarity—the significance of what was copied.

[47] When a CliPlugin defines a new command, the method Mode.addCommand() in CliParser.py (Mode in CliParser.py) is invoked.

92. I have further been informed that copyright subsists in original works of authorship fixed in any tangible medium of expression from which they can be perceived, reproduced, or otherwise communicated, including literary works and compilations. In the copyright context, a literary work is a non-audiovisual work that is expressed in words, numbers, or other verbal or numerical symbols or indicia, regardless of the nature of the material objects in which they are embodied. An example of a literary work is a computer program, which is a set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result. A compilation is a work formed by the collection and assembling of preexisting materials that are selected, coordinated, or arranged in such a way that the resulting work as a whole constitutes an original work of authorship. One type of compilation is a collective work, which is a work in which a number of contributions, constituting separate and independent works in themselves, are assembled into a collective whole.

93. I understand that copyright protection does not extend to facts, ideas, procedures, processes, systems, methods of operation, concepts, principles, and discoveries. Copyright protection does, however, extend to expressions.

94. I have been informed that a defendant is liable for vicarious copyright infringement if the defendant has profited from the infringing activity and has the right and ability to supervise the infringing activity, whether or not the defendant knew of the infringement.

95. I have been informed that a defendant is liable for contributory copyright infringement if the defendant knows or should have known of infringing activity by another and induces, causes, or materially contributes to the activity.

96. I understand that an infringement is considered willful when the plaintiff has proved that the defendant engaged in acts that infringed the copyright, and the defendant knew that those acts infringed the copyright or exhibited a reckless disregard for the plaintiff's intellectual property rights.

B. Ownership

97. I understand that Cisco owns copyrights in the programs, documentation, and other materials that relate to its IOS, IOS-XR, IOS-XE, and NX-OS operating systems ("Cisco IOS copyrighted works" or "Cisco copyrighted works"). These Cisco IOS copyrighted works include computer programs, screen displays/command line interfaces, and related documents that describe and define IOS and the IOS CLI, including the commands, modes, prompts, hierarchies, outputs, and command descriptions. I understand that each version of a Cisco operating system builds upon previous versions, and that Cisco separately registered copyrights for IOS copyrighted works in connection with at least the following operating system releases:

Copyrighted Work	Copyright Application	Copyright Registration	Copyright Registration Number	Publication	Registration
Cisco IOS 11.0	CSI-CLI-00356391 - CSI-CLI-00356394	CSI-CLI-00356395 - CSI-CLI-00356398	TXu-1-036-057	9/18/1995	6/14/2002
Cisco IOS 11.1	CSI-CLI-00356385 - CSI-CLI-00356388 CSI-CLI-00356500 - CSI-CLI-00356501	CSI-CLI-00356588 - CSI-CLI-00356591 CSI-CLI-00356562 - CSI-CLI-00356563	TXu-1-048-569 (supplementing TX-5-531-435)	3/1996	6/14/2002
Cisco IOS 11.2	CSI-CLI-00356578 - CSI-CLI-00356581	CSI-CLI-00356496 - CSI-CLI-00356499	TXu-1-036-063	10/1996	6/14/2002
Cisco IOS 11.3	CSI-CLI-00356538 - CSI-CLI-00356541 CSI-CLI-00356582 - CSI-CLI-00356587	CSI-CLI-00356446 - CSI-CLI-00356549 CSI-CLI-00356576 - CSI-CLI-00356577	TXu-1-057-804 (supplementing TXu-1-036-062)	12/1997	6/14/2002
Cisco IOS 12.0	CSI-CLI-00356520 - CSI-CLI-00356523 CSI-CLI-00356550 - CSI-CLI-00356555	CSI-CLI-00356516 - CSI-CLI-00356519 CSI-CLI-00356484 - CSI-CLI-00356485	TXu-1-057-805 (supplementing TXu-1-036-064)	11/1998	6/14/2002
Cisco IOS 12.1	CSI-CLI-00356512 - CSI-CLI-00356515	CSI-CLI-00356572 - CSI-CLI-00356575	TXu-1-057-807	3/2000	6/14/2002

	CSI-CLI-00356490 - CSI-CLI-00356495	CSI-CLI-00356506 - CSI-CLI-00356507	(supplementing TXu-1-036-066)		
Cisco IOS 12.2	CSI-CLI-00356508 - CSI-CLI-00356511 CSI-CLI-00356556 - CSI-CLI-00356561	CSI-CLI-00356506 - CSI-CLI-00356508 CSI-CLI-00356536 - CSI-CLI-00356537	TXu-1-057-806 (supplementing TXu-1-036-065)	5/2001	6/14/2002
Cisco IOS 12.3	CSI-CLI-00356524 - CSI-CLI-00356527	CSI-CLI-00356542 - CSI-CLI-00356545	TXu-1-188-975	Summer 2003	7/26/2004
Cisco IOS 12.4	CSI-CLI-00356486 - CSI-CLI-00356489	CSI-CLI-00356705 - CSI-CLI-00356705	TXu-1-259-162	5/2/2005	8/12/2005
Cisco IOS 15.0	CSI-CLI-00356480 - CSI-CLI-00356483	CSI-CLI-00356564 - CSI-CLI-00356567	TX 7-938-524	10/1/2009	11/28/2014
Cisco IOS 15.1	CSI-CLI-00356502 - CSI-CLI-00356505	CSI-CLI-00356532 - CSI-CLI-00356535	TX 7-938-525	3/26/2010	11/28/2014
Cisco IOS 15.2	CSI-CLI-00356528 - CSI-CLI-00356531	CSI-CLI-00356697 - CSI-CLI-00356700	TX 7-937-159	7/22/2011	11/24/2014
Cisco IOS 15.4	CSI-CLI-00356657 - CSI-CLI-00356660	CSI-CLI-00356653 - CSI-CLI-00356656	TX 7-938-341	11/24/2013	11/26/2014
Cisco IOS XR version 3.0	CSI-CLI-00356665 - CSI-CLI-00356668	CSI-CLI-00356618 - CSI-CLI-00356621	TXu-1-237-896	2004	4/29/2005
Cisco IOS XR version 3.2	CSI-CLI-00356661 - CSI-CLI-00356664	CSI-CLI-00356701 - CSI-CLI-00356704	TXu-1-270-592	2005	10/19/2005
Cisco IOS XR version 3.3	CSI-CLI-00356689 - CSI-CLI-00356692	CSI-CLI-00356642 - CSI-CLI-00356645	TXu-1-336-997	2006	7/19/2006
Cisco IOS XR version 3.4	CSI-CLI-00356634 - CSI-CLI-00356637	CSI-CLI-00356638 - CSI-CLI-00356641	TXu-1-344-750	2006	3/2/2007
Cisco IOS XR version 3.5	CSI-CLI-00356685 - CSI-CLI-00356688	CSI-CLI-00356614 - CSI-CLI-00356617	TXu-1-592-305	2007	7/17/2007
Cisco IOS XR version 4.3	CSI-CLI-00356681 - CSI-CLI-00356684	CSI-CLI-00356649 - CSI-CLI-00356652	TX 7-933-364	12/21/2012	11/14/2014
Cisco IOS XR version 5.2	CSI-CLI-00356626 - CSI-CLI-00356629	CSI-CLI-00356602 - CSI-CLI-00356605	TX 7-933-353	7/5/2014	11/14/2014
Cisco IOS XE version 2.1	CSI-CLI-00356693 - CSI-CLI-00356696	CSI-CLI-00356606 - CSI-CLI-00356609	TX 7-937-240	5/2/2008	11/24/2014
Cisco IOS XE version 3.5	CSI-CLI-00356610 - CSI-CLI-00356613	CSI-CLI-00356630 - CSI-CLI-00356633	TX 7-937-234	11/28/2011	11/24/2014
Cisco NX-OS Release 4.0	CSI-CLI-00356646 - CSI-CLI-00356648	CSI-CLI-00356622 - CSI-CLI-00356625	TX 7-940-713	4/2/2008	11/13/2014
Cisco NX-OS Release 5.0	CSI-CLI-00356599 - CSI-CLI-00356601	CSI-CLI-00356677 - CSI-CLI-00356680	TX 7-940-718	5/24/2010	11/13/2014
Cisco NX-OS Release 5.2	CSI-CLI-00356596 - CSI-CLI-00356598	CSI-CLI-00356673 - CSI-CLI-00356676	TX 7-940-727	7/29/2011	11/13/2014
Cisco NX-OS Release 6.2	CSI-CLI-00356593 - CSI-CLI-00356595	CSI-CLI-00356669 - CSI-CLI-00356672	TX 7-940-722	8/22/2013	11/13/2014

98. Much of the IOS-related programs, documentation, and other materials that I reviewed in preparing this report bear Cisco copyright notices, making it apparent that Cisco owns the copyrights to these materials.

C. Copyrightable Expressions in Cisco's CLI: Originality & Creativity

99. I understand that Cisco contends that hundreds of multi-word command expressions have been copied by Arista.[48] I also understand that Cisco contends that Arista copied the associated command modes, prompts, as well as the following command hierarchies:

- "aaa" command hierarchy
- "bgp" command hierarchy
- "clear" command hierarchy
- "dot1x" command hierarchy
- "ip" command hierarchy
- "ipv6" command hierarchy
- "neighbor" command hierarchy
- "show" command hierarchy
- "snmp-server" command hierarchy
- "spanning-tree" command hierarchy
- "vrrp" command hierarchy

100. I also understand that Cisco contends that original documentation such as user manuals and screen outputs relating to its copyrighted works have also been copied as well as command descriptions (also known as help descriptions, help screens, or "helpdesc").

101. It is my opinion that Cisco's asserted command expressions, hierarchies, modes, and prompts contain considerable original expression in their selection and arrangement. To start, designing a command syntax for a particular function is a subjective exercise that requires independent judgment of the author and numerous creative and expressive choices. For example, an author must select one or more individual words that she wants to use. The author must then determine the spelling of those words and whether to abbreviate or otherwise modify the traditional spelling. The author must determine what order to place the words in and the relationship, if any, that the words should have with one another. All of those decisions are left to the subjective judgement and creativity of the command author. In some respect, any one of

[48] *See* Exhibit 1 to Cisco's Second Amended Complaint.

the asserted command expressions could, in theory, be any random set of words or characters, and yet the command would still work. Choosing the words and the arrangement and the organization of those words is where the creativity lies.

102. My opinions are supported by sworn testimony of both Cisco and Arista. For example, Cisco distinguished engineer and IOS CLI creator Kirk Lougheed testified that as a general matter creating a piece of software is a creative process:[49]

> 24 THE WITNESS: Writing any piece of
> 25 software involves some degree of creativity. It may
> 1 not be at the Shakespearean level, but maybe more
> 2 prosaic. But you actually have to figure out
> 3 something. You have to create something to show how
> 4 stuff is done or to create something to communicate.
> 5 And that's what I was doing was creating something
> 6 to communicate to the customer, to the user of the
> 7 stuff, here is a command expression that will get
> 8 you information, and it's easy enough to understand
> 9 what was being done.

103. Mr. Lougheed also explained that crafting commands themselves is a creative process and that specific command expressions may change during that process based on the aesthetic sensibilities and subjective judgment of the author:[50]

> 10 Q Did you come up with the phrase "IP
> 11 address"?
> ***
> 3 It became clear that much more—that we
> 4 were becoming a multi-protocol router. We were
> 5 adding other protocols into the box, into the
> 6 software.
> 7 And I had—I value—I value the
> 8 aesthetic of having a symmetric-looking command line
> 9 expression, symmetric hierarchy. It was clear we
> 10 were heading towards a hierarchy.
> 11 So at some point after DECnet and perhaps

[49] Deposition Testimony of Kirk Lougheed Tr. at 338:24-339:9 (Apr. 4, 2016).

[50] Deposition Testimony of Kirk Lougheed Tr. at 128:10-129:19 (Nov. 20, 2015).

12 a few other protocols to make things look very
13 similar, we started prefacing our IP-only commands
14 with "IP." And that gave a very—what I thought
15 was a very elegant, symmetric, elegant way of
16 referring to different protocols within a
17 multi-protocol router.
18 So that is the history of the "IP address"
19 command.

104. Mr. Lougheed provided similar testimony for specific multi-word command expressions as well such as "show ip route,"[51] "show spanning-tree,"[52] "IP routing,"[53] "show hosts,"[54] "clear" hierarchy,[55] and "timers basic RIP."[56]

105. Another Cisco CLI command author, Mr. Abhay Roy, testified similarly. For instance, Mr. Roy testified that the creation of the command "bfd all-interfaces" was the result of looking at a variety of protocols, collectively discussing the best way to express the concept, considering how the command "fits into the bigger … pieces of organization of commands, what makes sense, [and] what is more aesthetically correct" within the framework of the system.[57] Mr. Roy also testified he considered many things when designing commands such as content, features, "what is being asked," and that during the creative process "you start with your best

[51] Deposition Testimony of Kirk Lougheed Tr. at 331:6-23 (April 4, 2016).

[52] *Id.* at 337:17-20.

[53] Deposition Testimony of Kirk Lougheed Tr. at 145:3-25 (Nov. 20, 2015).

[54] *Id.* at 168:21-169:16 (testifying that there were other command word options he could have chosen including "computers," "names," "systems," "network systems," "end systems").

[55] *Id.* at 174:5-175:4 ("it seemed aesthetically pleasing to me").

[56] *Id.* at 185:13-186:5.

[57] Roy Deposition Tr. at 24:12-25; 26:2-9 (discussing that command creation involves considering "overall architecture purity"); 45:6-20 (testifying that when creating commands Cisco wanted to make "smart choices" that made sense from an "aesthetic perspective" and from "the alignment and architectural perspective").

guess," which "may or may not be the best which will eventually have the light of day, but you go with your knowledge and your judgment."[58]

106. Another Cisco CLI command author, Mr. Devadas Patil, testified that the command creation process is subjective and implicates various considerations that are open to an author's own professional judgment:

- "Well, there is—the—the product owner, which is me, lead developer for the product, comes up with initial proposal, and it is, essentially, reviewed by a group of people that are highly experienced for—for usability and extensibility, and so on, so there are certain criteria that they look—look at, including usability, extensibility, aesthetics, etc."[59]

- "So there's a—there's a—there's a balance between future-proofing and—and verbosity, and—and the more you try to feature proof, the more verbose you can become, so it's more of a subjective column how you design, keeping all of these in mind, yeah."[60]

- "Yeah, so intuitiveness, extensibility, usability, aesthetics are all factors that we considered."[61]

107. Cisco engineer and CLI author Phillip Remaker's testimony confirms the same. Mr. Remaker testified that commands, *e.g.*, "show inventory," were created at Cisco through a collective discussion with other engineers (sometimes referred to as the Cisco "Parser Police") during which many different word choices were considered:[62]

> 2 Q. In your view, what's creative about the
> 3 command "show inventory"? Strike that.
> 4 What is creative about the command "show
> 5 inventory"?
> 6 MR. NEUKOM: Objection. Calls for a legal
> 7 conclusion and personal opinion. Also off topic.
> 8 THE WITNESS: For this particular command,
> 9 we spent a lot of time in discussion and considered

[58] *Id.* at 47:8-18.

[59] Patil Deposition Tr. at 161:19-162:1 (Feb. 21, 2016).

[60] *Id.* at 186:7-11.

[61] *Id.* at 187:1-9.

[62] Remaker Deposition Tr. at 114:2-15 (Mar. 31, 2016).

> 10 a lot of different ideas for how to go about doing
> 11 this command. And because we engaged a number of
> 12 people and spent a lot of serious time thinking
> 13 about the problem and how the customer would
> 14 interact with the command, I think that careful
> 15 consideration could be classified as creativity.

108. Communications from other Cisco engineers further confirm that the process of command expression creation is a subjective, creative endeavor. For example:

- Adam Sweeney (formerly of Cisco, now with Arista): "I agree with CLI naming is very subjective. . . . Review in this list gives us a chance to work towards consistency within this very subjective space."[63]

- Scott Lennartz (Cisco): "It is my belief that any exercise in naming is highly subjective, and there is rarely a 'right' answer . . . ."[64]

109. This collaborative, creative, expressive process is what ultimately led to the Cisco command syntax of Cisco's IOS CLI and "an aesthetic of the organization of the commands," which includes the "hierarchical notions, the modality, the organization of the commands, and the choices of the words."[65] And, as Mr. Remaker testified, one of the reasons why Cisco chose to organize commands into hierarchies was to "improve[] the readability of configurations."[66] In other words: "Instead of having a single configuration line with a lot of attributes, it makes more sense to have individual lines expressing each individual attribute."[67]

---

[63] CSI-CLI00608716.

[64] CSI-CLI00608716.

[65] Remaker Deposition Tr. at 98:22-99:12 (Mar. 30, 2016).

[66] *Id.* at 106:25-107:5.

[67] *Id.* at 107:7-12.

110. Accordingly, when the architects of Cisco's IOS[68] CLI decided to include a particular set of commands in the platform and to give the commands particular names and associated modes, they chose from a wide range of expressive options. And that is because a computer can be taught to understand and react to different words and multi-word inputs however the designer wants. In other words, the inventors of Cisco's IOS CLI commands did not have to include for technical reasons the specific words that are contained in the 500+ asserted command expressions. They were creative choices.

111. By way of example, the command "show" is an expression of the idea or concept of displaying a particular configuration status of the device. There are many different ways to implement that idea and many different ways to even express that idea. For example, the word "display," "print," "watch," "view," or "info" are equally sufficient ways to express this idea. Other words such as "steve" or "book" or "phone" would be used just as well—a computer can recognize any combination of letters and numbers. Indeed, other vendors—such as Huawei—implement a command hierarchy using the command "display" instead of "show."

112. Numerous Arista executives also have confirmed that the creation of command expressions is a creative process, that it is "very subjective," and that Arista is (and was) able to create new/different commands than the ones it copied from Cisco:

> 15 Q. Mr. Sweeney, based on your experience
> 16 working with CLI command syntax both at Cisco and at
> 17 Arista, would you agree that coming up with CLI
> 18 syntax for a particular command is very subjective?
> 19 A. It certainly is subjective, yes.
> 20 Q. And that means that different engineers
> 21 could come up with different ideas for the proper
> 22 CLI syntax for the same functionality, correct?
> 23 A. Yes.

[68] Unless otherwise noted, my use of the term "IOS" refers to IOS, IOS-XR, IOS-XE, and NX-OS collectively.

Deposition Testimony of Adam Sweeney (Arista VP of Software Engineering) at 175:15-23 (Jan. 29, 2016).

12 Q. Right. So at the end of the day,
13 selecting CLI syntax is a judgment call, true?
14 A. Yes.
15 Q. And what you were laying out are some of
16 the principals and style guidelines; but as you
17 said, these aren't mandatory rules, at the end of
18 the day, the Arista engineers should talk about it
19 and then use their judgment; is that right?
20 A. Yes.

Id. at 217:12-218:8.

5 Q. Well, let's just have that one sentence
6 read in.
7 A. Okay. It states:
8 "I agree that CLI naming is very
9 subjective."
10 Q. You wrote those words, correct?
11 A. I believe so.
12 Q. And you agree with that statement, true?
13 A. The "very" is maybe a little much, but,
14 yes.
15 Q. Okay. And then you say -- well, why don't
16 we have you read the next sentence into the record.
17 A. It states:
18 "That's why we have this list."
19 Q. And you wrote those words?
20 A. I believe so.
21 Q. And the list there is the parser-police
22 list, correct?
23 A. Yes.
24 Q. Okay. And can you read the next sentence
25 into the record.
1 A. It states:
2 "Review in this list gives us a chance
3 to work towards consistency within this
4 very subjective space."
5 Q. And, again, you wrote those words?
6 A. I think so.
7 Q. And you believe that those are true
8· statements?

A. Yes.
Q. Okay. And when it says: "very subjective space," what is that referring to?
A. I assume it means the space of CLI syntax.
Q. And you say in the next sentence:
"In my opinion..."
Can you read that.
A. "In my opinion, syntax consistency with features that have similar function is very important."

Deposition Testimony of Adam Sweeney (Arista VP of Software Engineering) at 184:5-185:18 (Jan. 29, 2016).

Q. If somebody said to you, Mr. Sweeney, there's only one way, only one way to express a command syntax for a particular CLI command to be used in a -- network equipment, would you agree with that statement?
A. No.
Q. And why not?
A. 'Cause it's not true.
Q. And based on your experience, you know it's not true, true?
A. Yes.

Deposition Testimony of Adam Sweeney (Arista VP of Software Engineering) at 186:21-187:6 (Jan. 29, 2016).

Is it possible for Arista to utilize a combination of the Linux interface and additional tools that Arista would develop to access the various functionality related to industry ratified protocols in Arista switches without using any of the CLI commands that overlap with Cisco?
A. It is certainly possible to create an alternate management approach for BGP that wouldn't use any commands that overlap with Cisco. But I think without designing a specific one it would be hard to know whether that would be a viable product from the point of view of the end user.
Q. You're saying you're not sure whether it would sell or not?

[redacted]

21 A. Yeah, there can be different choice of
22 words.
23 Q. Okay. So when you say it's industry
24 standard in that context, you're talking about the
25 means which is using a command line text entry on a
1 screen?
2 A. No, I mean they come from UNIX commands or
3 deck top commands, you know. So whether you say
4 "show" or "display," these are all prior English
5 words that were used in CLI. CatOS used display,
6 IOS used show. So even the Cisco operating systems
7 there are two different ways saying it.

Deposition Testimony of Jayshree Ullal (Arista President & CEO) at 253:14-254:7.

19 Q. And so for you, even if the guidelines
20 said something to you, you were making your own
21 decisions about what you thought was logical or not;
22 is that fair?
23 A. I would have certainly had my own opinion.
24 Whether that was the direction that went
25 down for any specific command, I—I don't recall
1 the specifics.
2 Q. And you do recall that different engineers
3 at Cisco had different opinions about how to express
4 certain CLI commands, do you recall that?
5 A. Yeah, sure.
6 Q. And you had your opinions, other people at
7 Cisco had their opinions on the same command
8 functionality, correct?
9 A. Yeah, I mean, we might have had opinions
10 the same way, they might have been different. It
11 depends on the exact circumstances.
***
4 The initial decision by an engineer to
5 propose a CLI expression, that's an individual
6 subjective choice, correct?
7 A. Sure. Someone needs to come up with a
8 command to start with.
9 Q. And so you as an engineer at Cisco, if you
10 were asked to express a CLI command expression for a
11 particular functionality that was being added, you
12 would come up with your preference and make a
13 subjective choice based on what you thought was the
14 best fit; is that true?
15 A. No, I don't—there are—I can think of

cases where that wouldn't be correct. I think there's certainly been cases where we've asked customers what they would like as commands or what they feel makes the most sense. So it's not always up to an engineer to come up with that.

Q. But it can be up to an engineer, you can have situations where an engineer can come up with a particular command expression for a functionality in CLI that is his preference, correct?

A. I guess so, sure.

Deposition Testimony of Lincoln Dale at 148:19-149:11, 150:4-25.

Q. But, Mr. Dale, you would agree with me that, just having said all of that, that two Cisco engineers could sit down and propose two different command expressions for any of these functions; isn't that true?

A. That's entirely possible.

Q. Okay. For example, although Cisco chose the word "show" to display information, another networking company could pick a different word, "display," for the same functionality, correct?

A. It's possible.

Q. And they could pick the word "visualize" rather than "show," correct?

A. It's possible. I mean, I—I know of a lot of companies that use the word "show" in your examples.

***

Q. Is there any technical reason why you couldn't choose the word "display" as a part of a CLI for implementing Ethernet switching?

A. Yeah, I think there's—sorry, can you repeat the question?

Q. Yeah. Is there a technical reason why you couldn't choose the word "display" as part of a CLI for implementing Ethernet switching?

A. I think you could choose any word for any command. I think there is something that makes the most logical sense. In my experience of working with customers, they like and value consistency. "Show" is a very unambiguous way of what a "show" command does.

Q. We're going to get to customers later. All I'm asking you right now as an engineer, is

there a technical reason why you couldn't design a CLI interface for Ethernet switching that used the word "display" instead of "show"?

A. There's -- sure, there's no reason why.

Deposition Testimony of Lincoln Dale at 152:9-25, 153:15-154:9.

Q. So how would a particular command proposal be approved by the parser-police if there was no central committee?

A. It was a distribute community group and you would just have to go convince the community and -- and debate with them if you needed to.

Q. Who—there would be debates among the members of the community about the pros and cons of various CLI command proposals; is that right?

A. I would say there would be different types of debates. Some of them would be, why are you implementing this command because a similar command already exists on a different platform or a different train of code; why didn't you just use the same.

The other one would be to make sure everything fits the language that IOS CLI had, which the users were used to.

And then there were debates on pros and cons as well.

***

Q. Could those arguments last days sometimes?

A. Yes.

Q. There were some pretty heated debates sometimes on the parser-police?

A. There were lots of debates. I don't remember them at this point. But yes.

Q. And engineers can have pretty strong opinions about what they think is right or wrong when it comes to CLI syntax, correct?

A. I think it's --

MR. FERRALL: Calls—calls for opinion testimony.

You can answer.

THE WITNESS: Engineers can have opinions. But also when it's a very large collection of engineers, then getting consensus is harder.

Anshul Sadana Deposition Tr. at 135:18-136:12, 137:11-138:1.

Q. So even with the same context it's possible that you, as an engineer, may come to a different professional judgment on the same question today compared to how you would have seen the issue back in 2003?

MR. FERRALL: Objection. Lacks foundation. Vague and ambiguous.

BY MR. PAK:

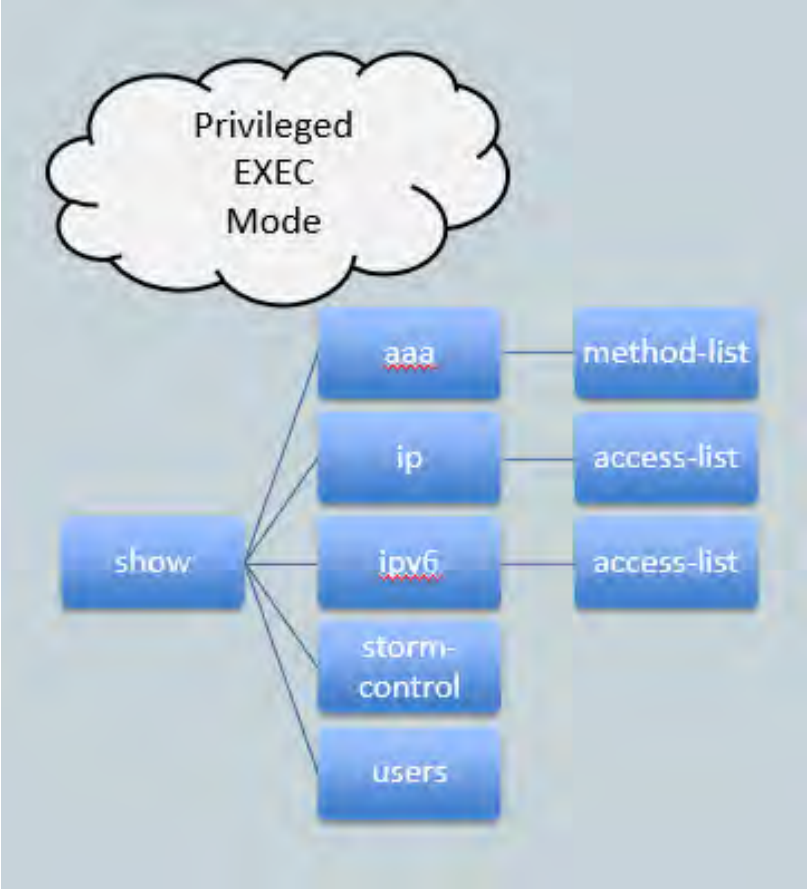
Q. Is that fair?

MR. FERRALL: Same objections.

THE WITNESS: You can always analyze something and end up with a different conclusion. In the CLI context I think you do learn over time what the structure is, what are the other commands, what is the language that everyone expects on that device and then you adhere to that. There's certainly learning there. And if you're trying to debate, there are choices you can make. But you need to know the full context to make the right

Anshul Sadana Deposition Tr. at 157:6-24.

113. The copied command hierarchies also contain considerable original expression. The decision to organize Cisco's IOS CLI commands into the designers' chosen hierarchy reflects the original choices of the designers. As an illustration, a sub-command hierarchy for "show" in Privileged EXEC mode is diagrammed below:



114. Through this particular design, the designers were able to convey that a specific set of second words or tokens would follow the initial token, and then a further set, etc. The hierarchy conveys to a user an aesthetic sense of the set of choices, *i.e.*, what is possible and what is not. In some cases (*e.g.*, the use of "access-list" as an option under multiple higher level tokens), the hierarchy helps to organize choices into parallel possibilities.

115. By branching initially on the dimension of "show" and then building out the hierarchy from there, the designers created an organizational structural that is aesthetically pleasing, easy to understand, and easier to remember (based on the subjective belief and professional judgment of Cisco's designers). A computer can execute the command "show_aaa_method-list" just as easily as it can execute a command called

"show_command_ipv6_access-list." The reason for choosing the organizational structure in the way that Cisco's designers did is so that they would have a unique command structure that Cisco's customers would easily be taught (again, based on the subjective belief and professional judgment of Cisco's designers) and because there was value in "the aesthetic of having a … symmetric hierarchy" that was "elegant."[69]

116. The decisions to organize Cisco's commands into modes with specific prompts reflects yet another conscious choice of expression. The command modes that I understand Cisco to be asserting in this case include "EXEC," "Privileged EXEC," "Global configuration," and "Interface configuration" (collectively, the "asserted command modes"). Rather than placing commands into different modes with unique prompts, the designers could have created a unified command structure without different modes and chosen a single prompt. Alternatively, Cisco's designers could have used different names for the asserted modes; for example, they could have chosen "ADMIN" instead of "EXEC" or "Secure ADMIN" instead of "Privileged EXEC." Similarly, "Universal setup" could have been chosen instead of "Global configuration" or "Edge setup" instead of "Interface configuration." Almost any other word choice could have been selected.

117. Further evidence that elements of Cisco's IOS CLI are creative is that they are what the user sees, what the user knows, and how the user talks to and interacts with the Cisco device. The user interface defines the user's experience. With the right selection of unique, intuitive commands and hierarchies—which Cisco endeavored to create on its own—Cisco built a successful business and became a market leader. That makes Cisco's IOS CLI distinctive compared to other competitors.

[69] Deposition Testimony of Kirk Lougheed Tr. at 128:10-129:19 (Nov. 20, 2015).

118. Moreover, that the commands are not particularly efficient or "perfect" in all respects confirms that they are not functional. [redacted]

- [redacted]
- [redacted]

119. Finally, the fact that there are other competitors in the market that implement different CLIs—*e.g.*, Juniper Networks, HP, Brocade, Alcatel-Lucent, and Extreme, among others—with different commands confirms that Cisco's multi-word command expressions are a creative expression. Indeed, a corporate representative from Hewlett Packard—a Cisco competitor—testified that there are multiple ways to implement commands, confirming that command creation is subjective and lends itself to diversity amongst competitors:

> 24 Q Now, you would agree with me, sir, that
> 25 there are multiple ways to implement a specific CLI
> 1 command, right?
> 2 A Yes, there are multiple ways to implement
> 3 CLI.
> 4 Q And different companies can and do, in
> 5 fact, create their own CLI commands using different
> 6 words and syntaxes, correct?
> 7 A Correct. The syntax may vary across
> 8 vendors.
> 9 Q And I believe you testified earlier that
> 10 vendors, in some instances, have their own
> 11 proprietary modifications to the industry standard

[70] ARISTANDCA 10491957

[71] ARISTANDCA10499890 at ARISTANDCA10499891.

12 command line interface, correct?
13 A Correct.
14 Q And does HP have its own proprietary
15 commands?
16 A I'm sure HP has proprietary extensions to
17 the CLI.
18 Q And in those instances, HP would be using
19 a different CLI command than, for instance, Juniper
20 to configure a network device, correct?
21 A Correct. HP syntax would be different and
22 documented.
***
6 Q Right. They can be similar but different?
7 A The syntax may vary.[72]

120. Arista's interrogatory response to Cisco's Interrogatory No. 10 further confirms my opinions. Arista's interrogatory shows it that there is a lot of diversity in command and mode choice and use in the industry, which further supports my opinion that the asserted command expressions are creative:[73]

Company	**Interrogatory No. 10 Mode/Prompt**	**Interrogatory No. 10 Command Overlap**
Adtran	1	178
Alcatel/Alcatel Lucent	4	140
Allied Telesis (formerly Allied Telesyn)	4	102
Aruba	0	5
Avaya	4	99
Bay Networks	0	2
Brocade Communications Systems	4	245
Checkpoint Technologies	0	74
Darkstar/XKL	0	33
D-link Corporation	4	305
Digital Equipment Corporation	0	5
Dell	4	270 (Arista included included

[72] HP Corporate Representative Tr. at 110:24-112:7 (May 2, 2016).

[73] I have assumed for purposes of this report only that Arista's response to Interrogatory No. 10 is accurate.

		Force 10 with Dell)
Edge-core Networks	4	221
Ericsson	4	164
Enterasys Networks (now owned by Extreme Networks)	0	22
Extreme Networks	4	95
F5 Networks	4	24
Force 10	4	See Dell
Foundry	4	165
HP	4	131 (HP and/or 3COM
IBM	4	0
ISCLI (including Blade Networks, IBM, and NEC products that support ISCLI)	0	107
Juniper JUNOSe	--	209
Juniper JUNOS	4	25
NextHop Technologies	--	223
Netgear	4	158
Nortel	4	0
Perle	4	29
Procket	0	104
RedBack Networks	--	66
Sun Microsystems	4	130 (and/or Oracle)

121. Accordingly, there is voluminous evidence that the Cisco IOS copyrighted works are Cisco original works including, for example, evidence on a command-by-command basis, showing the author/originator of each command, the earliest known document for each command, the date of earliest known document, the first operating system incorporating each command, and the date of first distribution of each command.[74]

[74] *See* Cisco's Response to Interrogatory No. 16 and Response to Interrogatory No. 19, Exhibit F (and all supplements thereto).

VI. EVIDENCE OF COPYING

122. For this comparison, I have compared the Cisco IOS copyrighted works to Arista's EOS operating system (including its CLI interface and screen displays) and related documentation.

123. I understand that IOS was built over time and that the later versions of IOS incorporate the technology and copyrights of the earlier versions.

124. I understand that every version of EOS has included Arista's EOS CLI command shell and interpreter.[75] Each version of EOS incorporates a CLI, CLI parser, CLI rule, and cli.py, and programs is, according to Arista's corporate representative, similar.[76] Arista sells and distributes EOS as a "single binary imagine" that is used "across all platforms."[77] Further, the structure and behavior relating to how CLI commands are parsed in EOS have not fundamentally changed over time.[78] As a result, the latest version of EOS "uses the same basic structures and algorithms" that Arista has used "since the beginning in [Arista's] implementation of the CLI."[79] Through my own inspection of Arista's programs as well as my inspection and testing of Arista's switches, I have confirmed that the operation of EOS for all accused versions for purposes of this report are substantially the same if not identical.

125. Unless otherwise noted, my opinions and analysis apply to all versions of EOS that Cisco has accused of infringement. As set forth below and in the exhibits accompanying my report, I have found evidence of copying in every version at issue in this case, and my opinions

---

[75] Sweeney Deposition Tr. at 416:12-15.

[76] Sweeney Deposition Tr. at 452:3-12.

[77] ARISTANDCA_SW_105998 at ARISTANDCA_SW_105998, ARISTANDCA_SW_105998, ARISTANDCA SW_10599845.

[78] Sweeney Deposition Tr. at 452:13-20.

[79] Sweeney Deposition Tr. at 452:21-453:5.

are further confirmed by Arista's responses to Interrogatory Nos. 9 and 26. I also note that Arista has not provided any evidence to suggest that there is a difference between its EOS versions that would change my opinions on copying, but if at a later date Arista attempt to make that argument for the first time, I reserve the right to supplement this report and/or or respond as needed.

126. As part of my analysis, I have examined the Cisco switches produced by Cisco's Counsel and the Arista switches produced by Arista's Counsel. For example, I used the switches to (1) confirm that the commands identified in the user manuals were available on the switches, (2) confirm that the output of the commands for each of the switches from both Cisco and Arista were the same or similar (where differences depend on the configuration settings of the switch) between what was described in the manual and what was provided in response to a command, (3) that the similarities in the outputs for the commands between the Cisco and Arista switches were as they were described in the manual. As part of my analysis, I have captured the screen output returned as a result of executing exemplary commands on the different switches.

127. The three Cisco switches are a 3560, a 4948E, and a N9K-C9372TX.[80] Pictures of each are shown on the top/first, middle/second, and bottom/third in the following pictures, respectively.

[80] I understand there was not a power source delivered for the N9K switch, and therefore, I did not perform the same kind of testing as with the other switches. But given my experience in the field and the consistency I found among the other Cisco switches and their manuals, it is my opinion that the Nexus N9K works as described in the corresponding manuals.

128. The two Arista switches are a 7010T-48 and a DCS-7554. The 7010T-48 is shown first, in the top picture, and the DCS-7554 is shown second, in the bottom picture.

129. The methodology I followed was to connect a serial cable to the console port of each switch, and then I used the PuTTY terminal to create a serial connection to the switch. The procedure I used to boot the device and connect to it was identical for the four switches. The N9K-C9372TX works in an identical fashion. Using PuTTY, I was able to log the commands I typed on each switch and the output returned by the switch. Below I include commands and output for Cisco 4948E and the two Arista switches.

130. Once connected to the switch I was able to log in. The Cisco switches immediately gave me a command prompt. For the Arista switches, I had to type the login "admin." None of the switches had passwords enabled for any of the command modes. Once logged in, I was able to execute commands via the CLI.

131. The version information for the Cisco 4948E is as follows:

```
Switch>show version
Cisco IOS Software, Catalyst 4500 L3 Switch Software (cat4500e-IPBASE-M), Version
12.2(54)SG1, RELEASE SOFTWARE (fc1)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2011 by Cisco Systems, Inc.
Compiled Thu 27-Jan-11 12:13 by prod_rel_team
Image text-base: 0x10000000, data-base: 0x12A709B8
ROM: 12.2(44r)SG12
Hobgoblin Revision 22, Fortooine Revision 1.22
Switch uptime is 1 minute
System returned to ROM by power-on
System image file is "bootflash:cat4500e-ipbase-mz.122-54.SG1.bin"
cisco WS-C4948E (MPC8548) processor (revision 5) with 1048576K bytes of memory.
Processor board ID CAT1552S66E
MPC8548 CPU at 1GHz, Cisco Catalyst 4948E
Last reset from PowerUp
1 Virtual Ethernet interface
48 Gigabit Ethernet interfaces
4 Ten Gigabit Ethernet interfaces
511K bytes of non-volatile configuration memory.
Configuration register is 0x2101
```

132. The version information for the Arista 7010T is as follows:

```
localhost#show version
Arista DCS-7010T-48
Hardware version:    01.01
Serial number:       HSH16130550
System MAC address:  444c.a88f.f7f9

Software image version: 4.14.9.1M
Architecture:           i386
Internal build version: 4.14.9.1M-2714873.41491M
Internal build ID:      0c909198-32d7-4253-85d6-d0f013b47dbc

Uptime:                 3 minutes
Total memory:           3907136 kB
Free memory:            1642992 kB
```

133. The version information for the Arista 7554 is as follows:

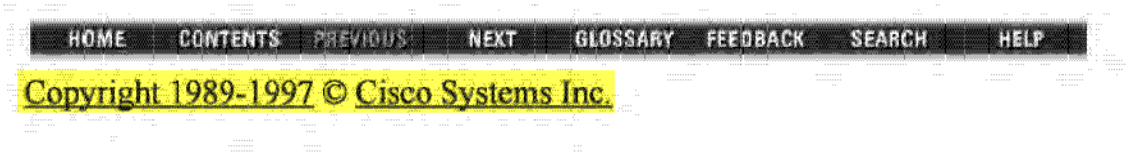
```
localhost(s1)>show version
Arista DCS-7554-CH
Hardware version:    02.01
Serial number:       HSH14525015
System MAC address:  001c.7374.c093

Software image version: 4.14.5.1F-SSU
Architecture:           i386
Internal build version: 4.14.5.1F-SSU-2384023.EOS41451FSSU
Internal build ID:      11a6d19e-4978-481d-abfc-968034d5b2d1

Uptime:                 1 minute
Total memory:           16012348 kB
Free memory:            13515668 kB
```

134. The following independent forms of copying are covered by this report: (i) Arista's copying of copyrighted expressions in programs (including CLI commands, modes, hierarchies, prompts and screen outputs) from Cisco's copyrighted works into both physical and electronic media; (ii) Arista's copying of copyrighted expressions in documents from Cisco's copyrighted works into both physical and electronic media; and (iii) Arista's copying of copyrighted expressions in screen displays from Cisco's copyrighted works into both physical and electronic media. I understand that each one of these forms of copying are, alone, sufficient to establish copyright infringement.

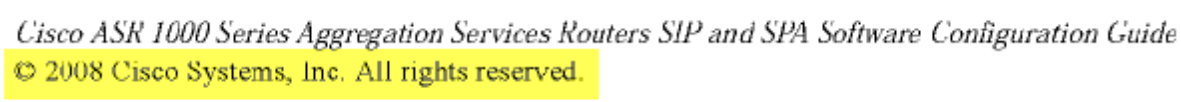
A. Arista Had Access To Cisco's Copyrighted Works & Admitted Copying

135. Arista had access to Cisco's copyrighted works through a variety of sources, and, based on my inspection of the testimony and documents available in this case, it is my opinion that Arista has copied Cisco's copyrighted expressions in its IOS copyrighted works.

136. Generally, Cisco's copyrighted documents such as its IOS-related manuals have been available to the public and on Cisco's website for years. Much of the Cisco documentation that I have personally observed contained a Cisco copyright notice, for example:



(IOS 11.0 (1989-1997), CSI-CLI-00430706)



(IOS-XE 2.1 (2008), CSI-CLI-00229755)

Text Part Number: OL-5903-04

(IOS-XR 3.2 (2005), CSI-CLl-00362851)

Americas Headquarters:
Cisco Systems, Inc., 170 West Tasman Drive, San Jose, CA 95134-1706 USA

(NX-OS 4.0 (2008), CSI-CLl-00362851)

137. Cisco's products incorporating the IOS CLI copyrighted works have been and are publicly available as well (some well before the founding of Arista), and the Cisco operating systems that I inspected running on Cisco devices all have copyright notices on them. Therefore, anyone who sees IOS running or the related documentation is aware (or should be aware) that Cisco has legal rights associated with IOS and its related materials.

[redacted]

[81] Deposition of Sean Hafeez Tr. at 40:20-41:12.

[redacted].

139. Additionally, I understand that a Cisco 806 broadband router was one of the "Network Resources" Arista made available to its engineers as they developed EOS so that they could analyze Cisco's IOS CLI[82] (in fact, this Cisco device was located on an Arista engineer's desk):

Network Resources

Here is a table of some things on the internal network that can be useful to get your work done.

Resource	How to access	Notes
Arastra Internal Web	**http://aweb**	Everything that we've automated internally.
AID server	**http://aid**	Arastra Internal Documents available on line.
Bugzilla	**http://bugs**	Our bug database.
Proglog	**http://proglog**	You can view or update logs people have created of what they've been working on.
Autobuild report	**http://abuild**	Indications of whether your prdject's autobuild is working or not, and if not, who is working on fixing things.
Benchmark report	**http://benchmark**	Historical records of our benchmarks (performance tests), viewable via your web browser.
cisco806	**telnet cisco806**	A real-life Cisco 806, which is a branch office VPN gateway. You can learn about the IOS CLI, logging, and general device behavior. The device is physically located on kduda's desk. All relevant usernames and passwords are "arastra".

140. I understand that Arista also had access to a Cisco 3560 device that Arista codenamed "cis01 box."[83] Among other things, Arista's engineers tested that device by entering

[82] ANI-ITC-944_945-0152061 at ANI-ITC-944 945-0152068.

[83] ARISTANDCA1199691 at ARISTANDCA1199692.

Cisco's CLI commands in an effort to "figure out the precise syntax" of Cisco's CLI commands. For example,[84] the documents show that Arista's engineers ran a parser dump in order to gain access to and display all available commands in Cisco's IOS CLI:[85]

```
cisco3560>show parser dump config-vlan
 Mode Name :config-vlan

1 name <string>
1 exit
1 mtu <576-18190>
1 state active
1 state suspend
1 said <1-4294967294>
1 media ethernet
1 media fddi
1 media tokenring
1 media fd-net
1 media tr-net
1 bridge type
1 bridge
1 bridge <0-15>
...
```

141. Arista also acquired a Nexus 5000 switch for performing a similar analysis[86] and gained access to Cisco's IOS copyrighted works. In fact, Arista does not dispute that Arista has created competitive reports analysis various products from Cisco.[87]

[redacted]

[84] ARISTANDCA12426192.

[85] *See also* Deposition of Duda Tr. at 307-310 (discussing parser dump); Deposition of Sweeney (30(b)(6) Vol. II) Tr. at 381-385.

[86] ARISTANDCA11417372.

[87] Deposition of Sadana (Rough) Tr. at 79:14-17 (May 27, 2016).

[88] Deposition of Sadana (Rough) Tr. at 74:1-23 (May 27, 2016); *see also* Sadana Exhibit 1303.

[89] Deposition of Sadana (Rough) Tr. at 74:24-75:14 (May 27, 2016); *see also* Sadana Exhibit 1303.

[redacted]

143. Many of Arista's engineers and executives are former Cisco employees. For example, Arista's CEO Jayshree Ullal—who initially "made her career at … Cisco Systems"—stated the following in an interview with Forbes magazine: "Since I helped build the enterprise, I would never compete with Cisco directly in the enterprise in a conventional way. It makes no sense. It would take me 15 years and 15,000 engineers, and that's not a recipe for success."[91] Other former Cisco employees who are or have been members of Arista's executive team and/or vice presidents include Andy Bechtolsheim, Anshul Sadana, Kenneth Duda, Isabelle Bertin-Bailly, Ed Chapman, Mark Foss, Christophe Metivier, Jeffrey Hurschman, Hugh Hollbrok, Jeff Raymond and Adam Sweeney, among others.

144. And in order for Arista customers to configure and use Arista's products, Arista requires them to use the commands that Arista built into its system, which means that Arista's customers also have access to Cisco's IOS copyrighted works to the extent that Arista incorporated those works into its products.

145. Furthermore, in both public and private fora, Arista has confirmed that it not only had access to Cisco's IOS CLI but that Arista's corporate preference was to copy Cisco: "Copying Cisco is good."[92] Some of the public statements include, by way of example, the following:

---

[90] Deposition of Sadana (Rough) Tr. at 75:15-77:9 (May 27, 2016); *see also* Sadana Exhibit 1303.

[91] *See, e.g.*, CSI-ANI-00356028, Adam Lashinsky, "An Ex-Cisco Exec Reflects," Fortune (Mar. 20, 2014), *available at* http://fortune.com/2014/03/20/an-ex-ciscoexec-reflects/.

[92] *E.g.*, ANI-ITC-944_945-3599339; ANI-ITC-944_945-3494444; ANI-ITC-944_945-3354465; and ANI-ITC-944_945-3494383; ANI-ITC-944_945-3468759.

- "[A] Cisco CCIE expert would be able to use Arista right away, because we have a similar command-line interface and operational look and feel. Where we don't have to invent, we don't."[93]

- Arista has tried to "[p]rovide familiar interfaces to ease adoption" including a "standard CLI that … retains familiar management commands" such that "80% [of Arista customers] tell [Arista] they appreciate the way they can leverage their deep [Cisco] IOS experience, as they can easily upgrade an aging [Cisco] Catalyst infrastructure to Arista."[94]

- "Familiar management interfaces, standard CLI … It's been very helpful for our customers to be able to rapidly adopt our products and integrate them into their environments … that our switches provide a familiar management interface so their existing tools and processes, screen scraping, automation, continue to work just as they did before."[95]

- "The familiar EOS command-line interface (CLI) avoids retraining costs."[96]

146. Arista's CTO Kenneth Duda also admitted during a recorded interview that Arista "slavishly" copied Cisco:

- "We want to minimize the transition costs to our customers. Our customers come very well trained, big staffs of people who understand that—that particular CLI. We actually copied it slavishly. You know it's like—even the things we thought were really silly, we went ahead and copied them anyway . . . . "[97]

---

[93] CSI-ANI-00381280, John Gallant, "How Arista Networks Got Out In Front of the SDN Craze," Network World (Feb. 22, 2013).

[94] Posting of Kenneth Duda to Arista EOS Central, "Linux as a Switch Operating System: Five Lessons Learned" (Nov. 5, 2013), *available at*https://eos.arista.com/linux-as-a-switch-operating-system-five-lessons-learned/.

[95] Arista, *EOS Bits & Bytes - Episode 1 - Lessons Learned While Building a Network OS on Top of Linux*, Arista EOS Central - Video Library (Jan. 30, 2014), at 6:55–7:56, *available at* http://eos.arista.com/wpcontent/themes/aristaeos/video-lightbox.php?vid=ttp6lavHKGo.

[96] Arista, *EOS: An Extensible Operating System*.

[97] Packet Pushers Clip (Audio File) (Duda Exh. 274).

147. In another public statement, Arista's CEO admitted that Arista had wrongfully copied at least portions of Cisco's copyrighted product documentation.[98]

[redacted]

[98] *See, e.g.*, Business Insider, "Cisco Just Fired Another Shot At Its Hated Rival, An Upstart Formed by Ex-Cisco Employees," Dec. 19, 2014, *available at* http://www.businessinsider.com/cisco-justfied-another-shot-at-arista-2014-12; New York Times, "Arista's Chief Executive Counters Cisco Lawsuit," Dec. 10, 2014, *available at* http://bits.blogs.nytimes.com/2014/12/10/aristas-chiefexecutive-counters-cisco-lawsuit/?_r=0.

[99] Duda Dep. (ITC) Tr. at 217:7–16, 218:17–19 ("Q: Is it accurate that Cisco has been very innovative? A: I believe that it is."), 219:3–8 ("Q: Okay. Is it correct that you told your CEO that Cisco has been much more innovative at the network architecture level than Arista? A: Yes. Q: Is that an accurate statement? A: I believe that it is."), 481:13–16, 482:24–483:5; *see also* Bechtolsheim Dep. (ITC) Tr. at 225:5–9.

[100] Sadana Dep. (ITC) Tr. at 211:14–22, 212:9–15, 217:8–21, 221:18–23, 228:17–22, 231:23–25.

[101] Bechtolsheim Dep. (ITC) Tr. at 240:7–21.

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[103] ANI-ITC-944_945-1365341 at ANI-ITC-944_945-136534.

[104] ARISTANDCA11406349.

[105] ANI-ITC-944_945-3451012.

[106] ARISTANDCA1206055.

[107] ANI-ITC-944_945-3937682 at ANI-ITC-944_945-3937685.

[108] ARISTANDCA11411864-ARISTANDCA11411865.

[redacted]

[109] ARISTANDCA1141720.

[110] ANI-ITC-944_945-3453648.

[111] ARISTANDCA 12060827.

[112] ARISTANDCA119969.

[113] ARISTANDCA10499890 at ARISTANDCA10499893.

[114] *Id.* at ARISTANDCA10499891.

[redacted]

[115] *Id.* at ARISTANDCA10499891.

[116] *Id.* at ARISTANDCA10499890.

[117] *Id.* at ARISTANDCA10499890.

[redacted]

[119] ANI-ITC-944_945-3927203 at ANI-ITC-944_945-3927205.

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[120] ARISTANDCA10526625.

[121] ARISTANDCA10525014.

[122] ARISTANDCA1199299.

[123] ANI-ITC-944_945-3473603.

[124] ARISTANDCA 10508650.

[125] ARISTANDCA 10537469-ARISTANDCA 10537470.

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[126] ARISTANDCA1206372.

[127] ARISTANDCA 10430978.

[128] ARISTANDCA 10430978.

[129] I do note that Arista's own interrogatory responses are internally inconsistent with one another. For example, Arista's response to Interrogatory No. 26 suggests that "ip proxy-arp" was implemented in 2005, which is entirely inconsistent with its response to Interrogatory No. 9 as well as its own internal emails.

[130] ARISTANDCA104437.

[131] ARISTANDCA11996066.

[132] ARISTANDCA10446381.

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[133] ARISTANDCA1194925.

[134] ANI-ITC-944_945-349442 to ANI-ITC-944_945-3494425.

[135] ARISTANDCA1200259.

[136] ARISTANDCA1059782.

[137] ARISTANDCA119495.

[138] ANI-ITC-944_945-0006860.

[139] ARISTANDCA 10384101.

[140] QuestNET Conference July 2013, slide 38.

- [redacted]

- [redacted]

- [redacted]

- [redacted]

[redacted] [redacted]

[redacted]

---

141 ANI-ITC-944_945-0009544.

142 ANI-ITC-944 945-1688838.

143 ARISTANDCA1266331-ARISTANDCA1266331.

144 ARISTANDCA_SW_105998 at ARISTANDCA SW_10599845.

[redacted]

[145] ANI-ITC-944_945-3452525.

[146] ANI-ITC-944_945-3452525 at ANI-ITC-944_945-3452526.

[147] ANI-ITC-944_945-3452525 at ANI-ITC-944_945-3452537-39.

[148] ANI-ITC-944_945-3452525 at ANI-ITC-944_945-3452537-39.

[redacted]

[149] CSI-CLI-00540078 at CSI-CLI-00540079.

[150] ARISTANDCA13165595 ("FeatureRequests" tab); *see also* ANI-ITC- 944_945 3663673; ANI-ITC- 944_945 3930871.

153. Moreover, when Arista executive Anshul Sadana was asked as his deposition if he told customers that Arista's CLI was just like Cisco's CLI, he did not deny it:

> Q. Are you denying, sir, that you told Arista customers that your CLI is just like Cisco's CLI?
> A. That's not what you asked.
> Q. I'm asking you that question right now. Are you denying, sir, that you told Arista customers that your CLI is just like Cisco's CLI?
> A. I'm not denying that.
> Q. You said that, correct?
> A. No. Yeah, I said that.
> Q. Yeah?
> A. Yeah.

Anshul Sadana Deposition Tr. at 236:4-14.

154. Arista's acts of copying with respect to the creative expressions in Cisco's programs including its CLI interface extend to not only programs such as all version of Arista's EOS operating system, but to printed and electronic documents distributed by Arista such as various versions of Arista User Manual for EOS and related documents used to train Arista's engineers, salesforce, distribution partners and customers.[151] For example, Arista's User Manual

[151] *E.g.*, Arista Networks EOS User Manual Version 4.4.0 (CSI-CLI-00007473), Arista Networks EOS User Manual Version 4.0.1 (CSI-CLI-00007244), Arista Networks EOS User Manual Version 4.6.2 (CSI-CLI-00006858), Arista Networks EOS User Manual Version 4.10.0 (CSI-CLI-00007841), Arista Networks EOS User Manual Version 4.11.1 - Rev. 2 (CSI-CLI-00010517), Arista Networks EOS User Manual Version 4.11.2.1 (CSI-CLI-00008985), Arista Networks EOS User Manual Version 4.12.4 (CSI-CLI-00014141), Arista Networks EOS User Manual Version 4.13.7M (CSI-CLI-00011973), Arista Networks EOS User Manual Version 4.14.3F - Rev. 2 (CSI-CLI-00018146), Arista Networks EOS User Manual Version 4.14.5F -

for EOS contains unauthorized reproductions of Cisco's copyrighted command expressions in its Command Reference section, as well in the detailed descriptions of such command expressions.[152] Similarly, the same Arista manual also contains unauthorized reproductions of Cisco's copyrighted screen displays.[153]

B. Cisco's CLI Documentation Compared to Arista's CLI Documentation

155. I understand that Cisco contends that Arista has copied creative expressions in Cisco's product documents that describe and relate to its CLI.[154] I agree with Cisco.

156. To start, I note that Arista's CEO admitted at a technology conference after this lawsuit was filed that Arista copied copyrighted expressions in Cisco's technical documents:

> "The first claim is in the technical-documentation area, and they say that we have copied pieces of their documentation. We have done a thorough review over the weekend, and to the best of our ability we can see that—this is something that is completely unacceptable to me, that less than 1% has been copied. We are taking care of the individual and personnel who's doing it. I own up to that. That's a mistake. I apologize to Cisco for it. We're going to fix it in a week."[155]

157. Ms. Ullal also admitted under oath that Arista copied creative expressions in Cisco's technical documents and that this conduct was improper:[156]

> Q: Let me take that in smaller chunks. You discovered that one of your engineers had copied some portion of a Cisco manual into an Arista manual?
> A: Yes.

Rev. 2 (CSI-CLI-00000084), Arista Networks EOS User Manual Version 4.14.6M (CSI-CLI-00004616), Arista Networks EOS User Manual Version 4.15.OF - Rev. 2.27 (CSI-CLI-00020575), Arista Networks EOS User Manual Version 4.15.0F (CSI-CLI-00002332), Arista Networks EOS User Manual Version 4.13.6F (CSI-CLI-00016001).

[152] *See, e.g.*, Exhibit Copying-1.

[153] *See, e.g.*, Exhibit Copying-3.

[154] *See* Second Amended Complaint; *see also* Cisco's responses to Interrogatory Nos. 2-4.

[155] CSI-CLI-00357842 at CSI-CLI-00357849 (emphasis added).

[156] Ullal Dep. (ITC) Tr. at 58:1–12, 61:22–25.

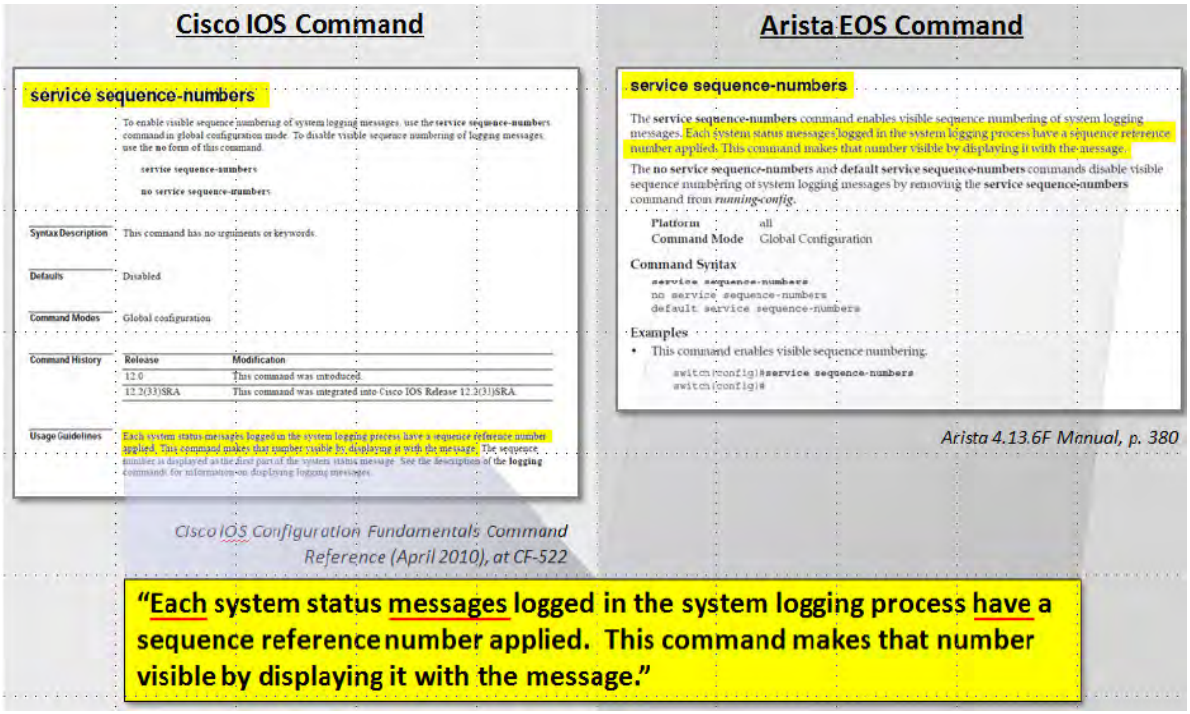
Q: And those were technical manuals; is that correct?
A: Yes, the technical documents that described the EOS software or installation configuration, et cetera.
Q: And you believed that that was improper behavior, right?
A: Absolutely.

158. I also have confirmed that there are many similarities between Arista's user manuals and Cisco's documents. The Arista user manuals that reflect these similarities include the following:

Date	Manual	Bates Begin	Bates End
4/8/2009	Arista Networks EOS User Manual Version 4.0.1	CSI-CLI-00007244	CSI-CLI-00007472
3/31/2010	Arista Networks EOS User Manual Version 4.4.0	CSI-CLI-00007473	CSI-CLI-00007840
3/28/2011	Arista Networks EOS User Manual Version 4.6.2	CSI-CLI-00006858	CSI-CLI-00007243
7/19/2012	Arista Networks EOS User Manual Version 4.10.0	CSI-CLI-00007841	CSI-CLI-00008984
1/22/2013	Arista Networks EOS User Manual Version 4.11.1 - Rev. 2	CSI-CLI-00010517	CSI-CLI-00011972
3/1/2013	Arista Networks EOS User Manual Version 4.11.2.1	CSI-CLI-00008985	CSI-CLI-00010516
9/16/2013	Arista Networks EOS User Manual Version 4.12.4	CSI-CLI-00014141	CSI-CLI-00016000
4/14/2014	Arista Networks EOS User Manual Version 4.13.6F	CSI-CLI-00016001	CSI-CLI-00018140
6/17/2014	Arista Networks EOS User Manual Version 4.13.7M	CSI-CLI-00011973	CSI-CLI-00014140
10/2/2014	Arista Networks EOS User Manual Version 4.14.3F - Rev. 2	CSI-CLI-00018146	CSI-CLI-00020337
12/22/2014	Arista Networks EOS User Manual Version 4.14.5F - Rev. 2	CSI-CLI-00000084	CSI-CLI-00002331
1/19/2015	Arista Networks EOS User Manual Version 4.14.6M	CSI-CLI-00004616	CSI-CLI-00006857
4/2015	Arista Networks EOS User Manual Version 4.15.OF - Rev. 2.27	CSI-CLI-00020575	CSI-CLI-00022852
4/18/2015	Arista Networks EOS User Manual Version 4.15.OF	CSI-CLI-00002332	CSI-CLI-00004615

159. When analyzing Arista's and Cisco's documentation, I observed similarities (in some instances word-for-word matching) as between sentences, paragraphs, the structure and organization of text and figures, and other similarities that—based on my experience analyzing plagiarism—suggests that copying has taken place.

160. As one example of verbatim matching, and as Cisco alleged in its complaint, Arista's user manuals include unique grammatical errors that existed in Cisco's documentation. For example:[157]



161. I confirmed these specific passages reside in both Cisco and Arista documents and contain the same words verbatim. Based on my experience, the likelihood of Arista independently writing these two particular sentences and including the exact same words (28

[157] *See* Second Amended Complaint at ¶ 55; *see also* Cisco IOS Configuration Fundamentals Command Reference at CF-522 (Apr. 2010); CSI-CLI-00016001, Arista 4.13.6F Manual at 380 (Apr. 2014).

words total) in the exact same order with the exact same anomalous grammatical error is close to zero.

162. Arista's user manuals also contain identical paragraphs to Cisco's documentation. For example, Arista's description of the "ip extcommunity-list" command contains identical descriptions of the "route target" and "site of origin" attributes, as shown below.

Route Target Extended Community Attribute

The route target (RT) extended community attribute is configured with the **rt** keyword. This attribute is used to identify a set of sites and VRFs that may receive routes that are tagged with the configured route target. Configuring the route target extended attribute with a route allows that route to be placed in the per-site forwarding tables that are used for routing traffic that is received from corresponding sites.

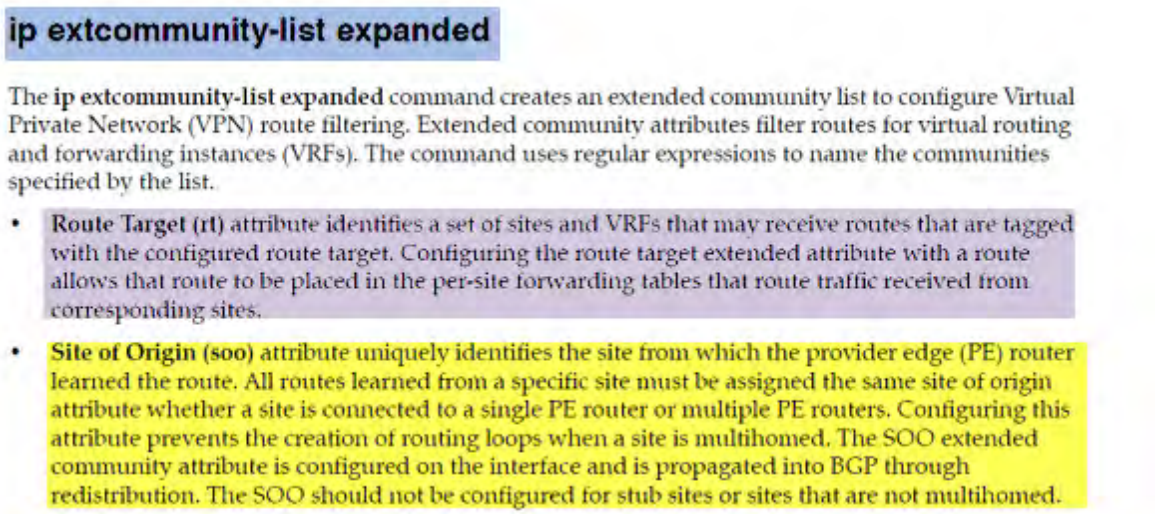
Site of Origin Extended Community Attribute

The site of origin (SOO) extended community attribute is configured with the **soo** keyword. This attribute uniquely identifies the site from which the provider edge (PE) router learned the route. All routes learned from a particular site must be assigned the same site of origin extended community attribute, regardless if a site is connected to a single PE router or multiple PE routers. Configuring this attribute prevents routing loops from occurring when a site is multihomed. The SOO extended community attribute is configured on the interface and is propagated into BGP through redistribution. The SOO should not be configured for stub sites or sites that are not multihomed.

IP Extended Community-List Configuration Mode

Named and numbered extended community lists can be configured in IP Extended community-list configuration mode. To enter IP Extended community-list configuration mode, enter the **ip extcommunity-list** command with either the **expanded** or **standard** keyword followed by the extended community list name. This configuration mode supports all of the functions that are available in global configuration mode. In addition, you can perform the following operations:

(CSI-CLI-00408381, Cisco IOS IP Routing Protocols Command Reference, Release 12.4 (2005), at IRP-118, CSI-CLI-00408502)



ip extcommunity-list expanded

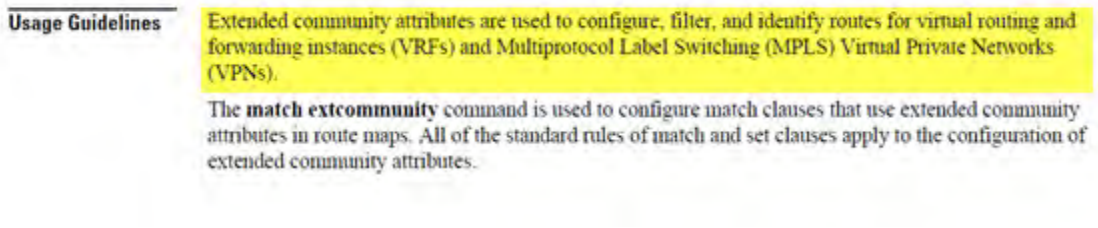
The **ip extcommunity-list expanded** command creates an extended community list to configure Virtual Private Network (VPN) route filtering. Extended community attributes filter routes for virtual routing and forwarding instances (VRFs). The command uses regular expressions to name the communities specified by the list.

- **Route Target (rt)** attribute identifies a set of sites and VRFs that may receive routes that are tagged with the configured route target. Configuring the route target extended attribute with a route allows that route to be placed in the per-site forwarding tables that route traffic received from corresponding sites.
- **Site of Origin (soo)** attribute uniquely identifies the site from which the provider edge (PE) router learned the route. All routes learned from a specific site must be assigned the same site of origin attribute whether a site is connected to a single PE router or multiple PE routers. Configuring this attribute prevents the creation of routing loops when a site is multihomed. The SOO extended community attribute is configured on the interface and is propagated into BGP through redistribution. The SOO should not be configured for stub sites or sites that are not multihomed.

(CSI-CLI-00016001, Arista User Manual v. 4.13.6F (4/14/2014), at 1540)

163. The only difference between these two examples is that Arista chose to use bullet points instead of sub-headings and then incorporated the attribute name for route target and site of origin into the introductory sentences instead of using them as sub-headings (as in Cisco's documentation). Otherwise, the selections are identical.

164. As another example, Arista's description of the "extended community" attributes in its user manual is identical to Cisco's. Indeed, the only difference is that Arista chose to remove the words "are used to" and add "BGP" to the beginning of the sentence:



Usage Guidelines

Extended community attributes are used to configure, filter, and identify routes for virtual routing and forwarding instances (VRFs) and Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs).

The **match extcommunity** command is used to configure match clauses that use extended community attributes in route maps. All of the standard rules of match and set clauses apply to the configuration of extended community attributes.

(CSI-CLI-00261229, Cisco IOS IP Routing: EIGRP Command Reference (2011), at 92, CSI-CLI-00261326)

BGP extended communities configure, filter, and identify routes for virtual routing, forwarding instances (VRFs), and Multiprotocol Label Switching (MPLS) Virtual Private Networks (VPNs).

Extended community clauses provide route target and site of origin parameter options:

(CSI-CLI-00016001, Arista User Manual v. 4.13.6F (4/14/2014), at 1502)

165. Arista's user manuals also include similar structural elements that are virtually identical to Cisco's documentation, such as the re-produced output for the "show port-security" command (shown below). Not only the text is virtually identical, but that Arista's table is structured and formatted in the same way with the same number of columns (five) arranged in the same order as Cisco's table:

Command Examples This example shows the output from the **show port-security** command when you do not enter any options:

```
Router# show port-security
Secure Port      MaxSecureAddr  CurrentAddr  SecurityViolation  Security
Action
                   (Count)        (Count)       (Count)
-------------------------------------------------------------------------

    Pa5/1          11             11            0              Shutdown
    Pa5/5          15             5             0              Restrict
    Pa5/11         5              4             0              Protect
-------------------------------------------------------------------------
```

(CSI-CLI-00261229 - CSI-CLI-00261480, Cisco IOS IP Routing: EIGRP Command Reference (2011), at 92, CSI-CLI-00261326)

Example

- These commands enable MAC security on Ethernet interface 7, set the maximum number of assigned MAC addresses to 2, assigns two static MAC addresses to the interface, and clears the dynamic MAC addresses for the interface.

```
switch(config)#interface ethernet 7
switch(config-if-Et7)#switchport port-security
switch(config-if-Et7)#switchport port-security maximum 2
switch(config-if-Et7)#exit
switch(config)#mac address-table static 0034.24c2.8f11 vlan 10 interface ethernet 7
switch(config)#mac address-table static 4464.842d.17ce vlan 10 interface ethernet 7
switch(config)#clear mac address-table dynamic interface ethernet 7
switch(config)#show port-security
Secure Port      MaxSecureAddr  CurrentAddr  SecurityViolation  Security Action
                   (Count)        (Count)       (Count)
-------------------------------------------------------------------------
    Et7            2              2             0              Shutdown
-------------------------------------------------------------------------
```

(CSI-CLI-00016001, Arista User Manual v. 4.13.6F (4/14/2014), at 624)

166. Another example of strikingly similar structure arrangements—coupled with nearly verbatim word matching—exists in the description of security levels, Arista and Cisco list the same number/name for various severity levels with identical descriptions of each level:

severity-level	(Optional) The number or name of the desired severity level at which messages should be logged. Messages at or numerically lower than the specified level are logged. Severity levels are as follows (enter the number or the keyword): **[0 | emergencies]** —System is unusable **[1 | alerts]**—Immediate action needed **[2 | critical]**—Critical conditions **[3 | errors]**—Error conditions **[4 | warnings]**—Warning conditions **[5 | notifications]**—Normal but significant conditions **[6 | informational]**—Informational messages **[7 | debugging]**—Debugging messages

(CSI-CLI-00291602, Cisco IOS Cisco Networking Services Command Reference (2013), at 91)

- ***CONDITION*** Specifies condition level. Options include:
  - <no parameter> Specifies default condition level.
  - **severity** <*condition-level*> Name of the severity level at which messages should be logged.

    Valid *condition-level* options include:
    - **0** or **emergencies** System is unusable
    - **1** or **alerts** Immediate action needed
    - **2** or **critical** Critical conditions
    - **3** or **errors** Error conditions
    - **4** or **warnings** Warning conditions
    - **5** or **notifications** Normal but significant conditions
    - **6** or **informational** Informational messages
    - **7** or **debugging** Debugging messages

(CSI-CLI-00018146, Arista User Manual v. 4.14.3F - Rev. 2 (10/2/14), at 155)

167. I have attached Exhibit Copying-1 that sets forth additional instances of similarities found between Arista's user manuals and Cisco's copyrighted documentation. As

shown above and in Exhibit Copying-1, Arista's manuals track Cisco's copyrighted documents word-for-word in many places and/or they include nearly identical sentences and structural elements, such as tables and lists. As discussed below, Arista's manuals also copy examples of Cisco's screen outputs, and Arista also copied those outputs into EOS.

C. Cisco's CLI Command Expressions Compared to Arista's CLI Command Expressions

168. I understand that Cisco has asserted that Arista copied over 500 specific multi-word command expressions that are elements of the Cisco IOS copyrighted works.

169. Arista does not dispute that its products and documentation such as product manuals use these multi-word command expressions.[158] For example, Arista admitted such use in its answer to Cisco's original complaint:[159]

> 53. Arista admits that it uses the IOS command expressions included in Exhibit 1 to Cisco's Complaint. Arista denies any remaining allegations of paragraph 53.

[redacted]

[158] *See* Arista's responses to Cisco's Interrogatory Nos. 9 (listing 516 commands) and 26 (listing 510 commands).

[159] Arista's Answer to the Complaint (Dkt. 36) at ¶ 53.

[redacted]

172. I have inspected the Cisco asserted command expressions and various Arista EOS products and documents and have confirmed that the asserted command expressions appear in an identical (or very similar) form in Arista's EOS. I have attached Exhibit Copying-2 that documents each instance of Arista's copying of Cisco's asserted command expressions. My analysis and opinions apply to all versions of Arista's EOS from the date a command was first incorporated into Arista's EOS and related-manuals to the present (unless otherwise noted), as provided by Arista in its response to Cisco's Interrogatory No. 9 and 26.

173. To further confirm Arista's use of the copied multi-word command expressions, I inputted commands into working versions of Arista's switch running EOS made available by Arista in this litigation at its lawyers' office. I also tested and inspected an Arista DCS-7048T-4S device running EOS 4.4.0 into which I also inputted multi-word command expressions.

174. When I input the commands, the Arista switch running EOS provided an output or response (not an error message) with the same look and feel as if I had inputted the commands into a Cisco device, which tells me that the multi-word command expressions are used in Arista's EOS in precisely the same way as they are in Cisco's IOS, and that a user would have a hard time knowing they were using an Arista switch instead of a Cisco switch. A log confirming my testing is provided as Exhibit Copying-7. The log confirms that EOS understands and knows how to respond to each of the commands, and that they are an integral part of EOS, including the CLI program with which the user interacts. I reserve the right to—and expect that as part of my trial testimony I will—demonstrate additional testing at trial, whether that be live or via video.

175. I do note that some of the multi-word command expressions Arista copied could not be run on the Arista switch in the limited environment provided by Arista. For certain commands to provide outputs, a live network environment is required to be set up and configured. During my inspections, however, the switches that Arista provided were not connected to a network or configured by Arista to simulate a live networking environment. Accordingly, my testing of commands that require a configured network was limited by the set up provided by Arista. Those limitations do not, however, impact my opinions, as I was able to

confirm through documentations and Arista's interrogatory responses that the commands expressions were and are implemented in EOS.[160]

176. I further note that nothing about network device hardware demands that manufacturers like Arista follow the particular structure and organization of the asserted command expressions that Arista has implemented. Nor are the multi-word command expression structures dictated by any external factors, such as industry standards (as discussed in more detail below). As discussed above, in designing a command structure, engineers are free to select a design that which reflects their creative, subjective views on how computer programs should be implemented. This was true when Cisco first designed its CLI, and it is equally true now. Arista avoided this labor-intensive process by adopting Cisco's established command structure.

D. Cisco's CLI Command Modes And Prompts Compared to Arista's Command Modes And Prompts

177. Exhibit C to Cisco's Second Supplemental Response to Interrogatory No. 2 identifies certain command modes and associated prompts that were created by Cisco and that Cisco alleges were copied by Arista. Cisco alleges that Arista's use of these command modes and prompts extends to interface-, feature-, protocol- and other more specific command modes and sub-modes, with associated prompts.

178. I independently verified the information in Exhibit C and agree with Cisco that Arista, in fact, uses these same command modes and prompts.

---

[160] *See* CSI-CLI-00007244, CSI-CLI-00007473, CSI-CLI-00006858, CSI-CLI-00007841, CSI-CLI-00010517, CSI-CLI-00008985, CSI-CLI-00014141, CSI-CLI-00016001, CSI-CLI-00011973, CSI-CLI-00018146, CSI-CLI-00000084, CSI-CLI-00004616, CSI-CLI-00020575, CSI-CLI-00002332; *see also* Arista's responses to Interrogatory Nos. 9 and 26.

179. To start, I note that Arista does not dispute that it uses the command modes and prompts that Cisco has accused it of copying, as it has admitted such use in its answer to Cisco's complaint:[161]

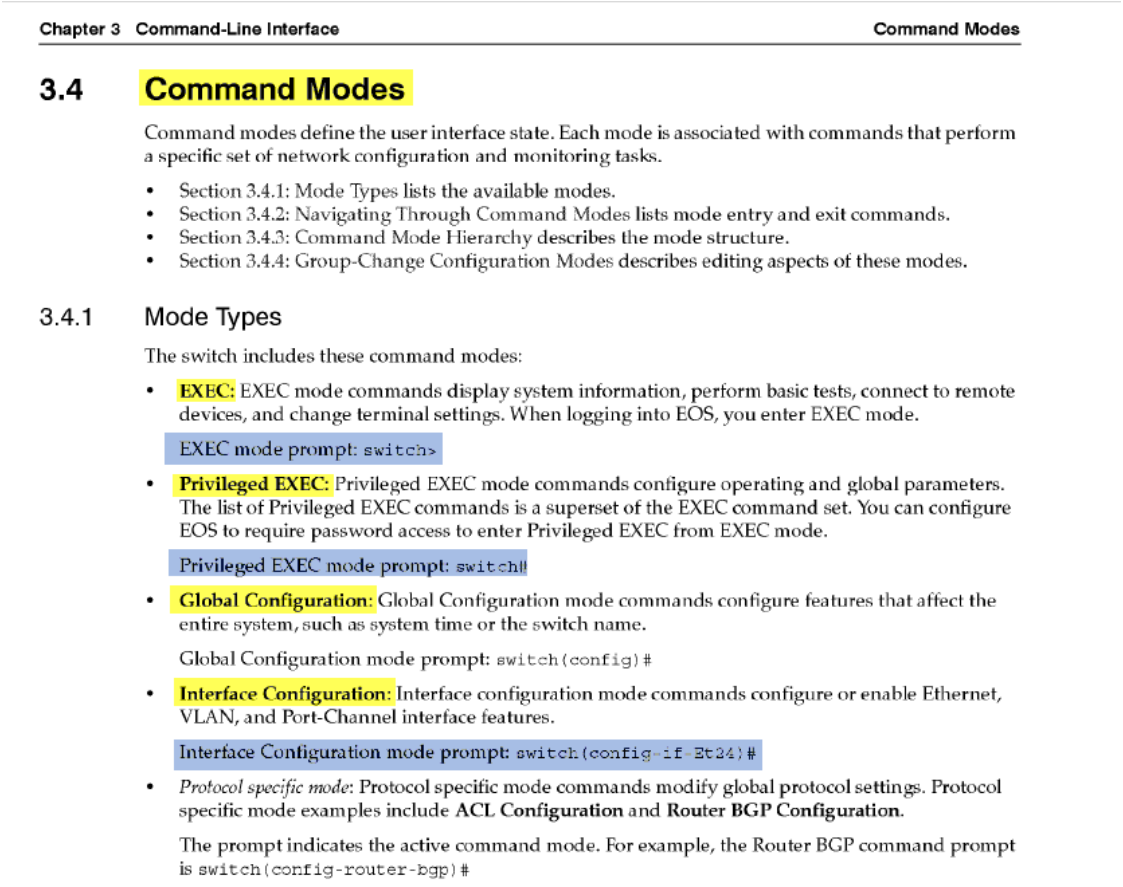
> 54. Arista admits that it uses the command modes and prompts identified under the subheading "Arista EOS Command Modes" in paragraph 54. Arista denies any remaining allegations of paragraph 54.

180. Arista's user manuals further confirm that across all versions of EOS, Arista has used the asserted command modes and prompts.[162] For example:[163]

[161] Arista's Answer to the Second Amended Complaint (Dkt. 65) at ¶ 54.

[162] Arista Networks EOS User Manual Version 4.4.0 (CSI-CLI-00007473), Arista Networks EOS User Manual Version 4.0.1 (CSI-CLI-00007244), Arista Networks EOS User Manual Version 4.6.2 (CSI-CLI-00006858), Arista Networks EOS User Manual Version 4.10.0 (CSI-CLI-00007841), Arista Networks EOS User Manual Version 4.11.1 - Rev. 2 (CSI-CLI-00010517), Arista Networks EOS User Manual Version 4.11.2.1 (CSI-CLI-00008985), Arista Networks EOS User Manual Version 4.12.4 (CSI-CLI-00014141), Arista Networks EOS User Manual Version 4.13.7M (CSI-CLI-00011973), Arista Networks EOS User Manual Version 4.14.3F - Rev. 2 (CSI-CLI-00018146), Arista Networks EOS User Manual Version 4.14.5F - Rev. 2 (CSI-CLI-00000084), Arista Networks EOS User Manual Version 4.14.6M (CSI-CLI-00004616), Arista Networks EOS User Manual Version 4.15.OF - Rev. 2.27 (CSI-CLI-00020575), Arista Networks EOS User Manual Version 4.15.0F (CSI-CLI-00002332), Arista Networks EOS User Manual Version 4.13.6F (CSI-CLI-00016001).

[163] CSI-CLI-00018146 at -264.



Chapter 3 Command-Line Interface Command Modes

3.4 Command Modes

Command modes define the user interface state. Each mode is associated with commands that perform a specific set of network configuration and monitoring tasks.

- Section 3.4.1: Mode Types lists the available modes.
- Section 3.4.2: Navigating Through Command Modes lists mode entry and exit commands.
- Section 3.4.3: Command Mode Hierarchy describes the mode structure.
- Section 3.4.4: Group-Change Configuration Modes describes editing aspects of these modes.

3.4.1 Mode Types

The switch includes these command modes:

- **EXEC:** EXEC mode commands display system information, perform basic tests, connect to remote devices, and change terminal settings. When logging into EOS, you enter EXEC mode.

  EXEC mode prompt: `switch>`

- **Privileged EXEC:** Privileged EXEC mode commands configure operating and global parameters. The list of Privileged EXEC commands is a superset of the EXEC command set. You can configure EOS to require password access to enter Privileged EXEC from EXEC mode.

  Privileged EXEC mode prompt: `switch#`

- **Global Configuration:** Global Configuration mode commands configure features that affect the entire system, such as system time or the switch name.

  Global Configuration mode prompt: `switch(config)#`

- **Interface Configuration:** Interface configuration mode commands configure or enable Ethernet, VLAN, and Port-Channel interface features.

  Interface Configuration mode prompt: `switch(config-if-Et24)#`

- *Protocol specific mode*: Protocol specific mode commands modify global protocol settings. Protocol specific mode examples include **ACL Configuration** and **Router BGP Configuration**.

  The prompt indicates the active command mode. For example, the Router BGP command prompt is `switch(config-router-bgp)#`

181. I further confirmed that Arista's EOS uses these commands and prompts through my own testing of three Arista switches. For each of the switches, I logged into the switch using the admin account. This account provides "EXEC" mode access. I then changed modes to "Privileged EXEC" mode by typing "enable" or "en." I note that on the switches I tested there was not a separate enable password. I also tested entering the "Global Configuration" mode by typing "configure" or "config" and entered in exemplary interfaces to enter the "Interface Configuration" mode. In each instance, the modes and the commands available in each mode were consistent with the manuals and documentation I reviewed.

182. It is evident from analyzing the modes and prompts that they are very similar if not identical to Cisco's modes and prompts. The following table illustrates the similarities:

Cisco Command Mode	Cisco Prompt	Identical or Similar Arista Command Mode	Identical or Similar Arista Prompt
User EXEC	router>	EXEC	switch>
Privileged EXEC	router#	Privileged EXEC	switch#
Global Configuration	router(config)#	Global Configuration	switch(config)#
Interface Configuration	router(config-if)#	Interface Configuration	switch(config-if)#
User EXEC	switch>	EXEC	switch>
Privileged EXEC	switch#	Privileged EXEC	switch#
EXEC	switch#	Privileged EXEC	switch#
Global Configuration	switch(config)#	Global Configuration	switch(config)#
Interface Configuration	switch(config-if)#	Interface Configuration	switch(config-if)#

183. With respect to the modes, six out of eight modes are word-for-word identical. With respect to the three modes that are not verbatim copies, there is nevertheless 50% overlap between Arista's modes and Cisco's modes. The difference arises because Arista chose to use the mode "EXEC" instead of "User EXEC" (*i.e.*, dropping the single word "User") and "Privileged EXEC" instead of "EXEC" switches (*i.e.*, adding a single word "Privileged").

184. With respect to the prompts, the switch-related prompts are identical across five prompts. There are no differences. And when I compared Cisco's router prompts to Arista's switching prompts, I note that the overall structures are the same. The only difference is that Arista uses the term "switch" instead of "router".

185. My analysis and conclusions apply to all versions of EOS accused in this case. My review of the materials in this case (including Arista's user manuals) shows that these modes and prompts have been used in every version of EOS accused in this case. *See* Exhibit Copying-4.

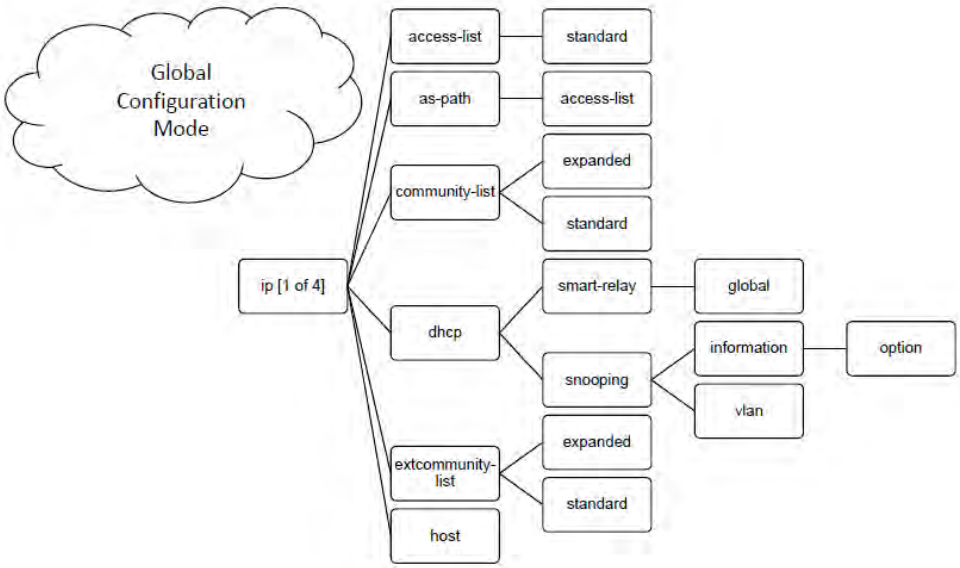
E. Cisco's CLI Command Hierarchy Compared to Arista's CLI Command Hierarchy

186. I understand that Cisco contends that Arista copied the following command hierarchies as well:

- "aaa" command hierarchy
- "bgp" command hierarchy
- "clear" command hierarchy
- "dot1x" command hierarchy
- "ip" command hierarchy
- "ipv6" command hierarchy
- "neighbor" command hierarchy
- "show" command hierarchy
- "snmp-server" command hierarchy
- "spanning-tree" command hierarchy
- "vrrp" command hierarchy

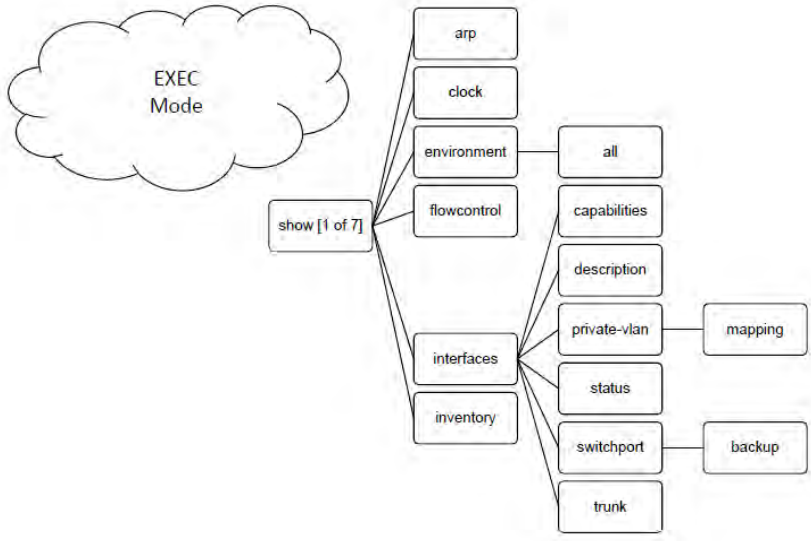
187. The command hierarchies in Amended Exhibit D1-D26 to Cisco's interrogatory responses contain Cisco's copyrighted command expressions that Arista copied in whole or in part by Arista. I have independently verified their contents and accuracy. I also have performed testing on Cisco and Arista devices through which I confirmed the information in Amended Exhibits D1-D26.

188. The hierarchies contained in Amended Exhibits D1-D26 identify multi-word command expressions. The hierarchies themselves are specific organizational and structural elements of Cisco's copyrighted works. The hierarchies are creative constructs that help a user's thought process when interacting with a network device. The hierarchies can be expressed visually by tree structures, for example, one "ip" hierarchy can be expressed as follows:



(D26 – NX-OS 6.2)

And a "show" hierarchy can be expressed as follows:



(D13 – IOS 15.4)

189. Each command hierarchy is associated with a configuration mode (*e.g.*, the "enable" EXEC command in EOS and IOS). What that means is that the command hierarchy

can only be used and accessed in that specific configuration mode. Associating modes with hierarchies adds an additional layer to the organization and structure of the CLI.

190. Based on my review of the documents, testimony, switches, and programs, it is my opinion that Arista uses the same or similar multi-word commands, with the same or similar multi-word syntaxes, organized into the same or similar hierarchies, and associated with the same or similar modes that are in Cisco's copyrighted works. These hierarchies are contained in Cisco's and Arista's respective product documentation and programs.[164] In my opinion, Arista's copying also is shown by its reproduction and use of the individual command expression in the same modes as the commands are located in Cisco's copyrighted works.

191. The following lists shows select examples of Arista's copying of hierarchies and sub-hierarchies contained in Cisco's copyrighted works:[165]

"aaa" command hierarchy, including the following exemplary multiword command(s) within the "aa group server" sub-hierarchy:	"aaa group server radius" "aaa group server tacacs+"
"bgp" command hierarchy, including the following exemplary multiword command(s) within that hierarchy:	"bgp client-to-client reflection" "bgp confederation identifier"
"clear" command hierarchy, including the following exemplary multiword command(s) within the "clear ip" sub-hierarchy:	"clear ip igmp group" "clear ip nat translation"
"dot1x" command hierarchy, including the following exemplary multiword command(s)	"dot1x max-reauth-req"
"ip" command hierarchy, including the following exemplary multi-word command(s) within that hierarchy:	"ip as-path access-list"
"ip dhcp" sub-hierarchy, including the following exemplary multi-word command(s):	"ip dhcp snooping"
"ip igmp" sub-hierarchy, including the following exemplary multi-word command(s):	"ip igmp last-member-query-count"

[164] CSI-CLI-00007473, CSI-CLI-00007244, CSI-CLI-00006858, CSI-CLI-00007841, CSI-CLI-00010517, CSI-CLI-00008985, CSI-CLI-00014141, CSI-CLI-00011973, CSI-CLI-00018146, CSI-CLI-00000084, CSI-CLI-00004616, CSI-CLI-00020575, CSI-CLI-00002332, CSI-CLI-00016001.

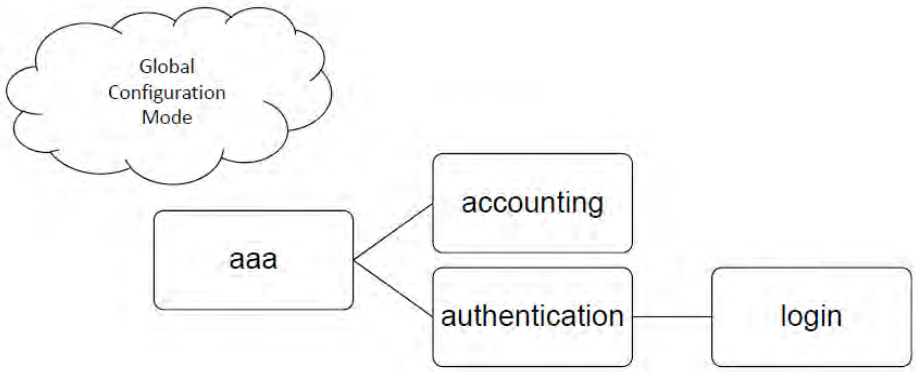
[165] *See* Cisco's Second Amended Complaint.

	"ip igmp static-group"
"ip msdp" sub-hierarchy, including the following exemplary multi-word command(s):	"ip msdp sa-filter in"
"ip ospf" sub-hierarchy, including the following exemplary multi-word command(s):	"ip ospf shutdown" "ip ospf transmit-delay"
"ip pim" sub-hierarchy, including the following exemplary multi-word command(s):	"ip pim dr-priority" "ip pim query-interval"
"ipv6" command hierarchy, including "ipv6 nd" sub-hierarchy, including the following exemplary multi-word command(s):	"ipv6 nd managed-config-flag" "ipv6 nd ns-interval"
"ipv6 ospf" sub-hierarchy, including the following exemplary multi-word command(s):	"ipv6 ospf cost"
"neighbor" command hierarchy, including the following exemplary multi-word command(s):	"neighbor ebgp-multihop" "neighbor route-reflector-client"
"show" command hierarchy, including the following exemplary multiword command(s)[166]:	"show aaa method-lists"
"show interfaces" sub-hierarchy, including the following exemplary multi-word command(s):	"show interfaces private-vlan mapping" "show ip" sub-hierarchy (at least 50 matches), including:
"show ip bgp" sub-hierarchy (at least 8 matches), including the following exemplary multi-word command(s):	"show ip bgp regexp" "show ip mroute"
"show ipv6" sub-hierarchy, including "show ipv6 ospf" sub-hierarchy, including the following exemplary multi-word command(s):	"show ipv6 ospf border-routers" "show ipv6 route" sub-hierarchy
"snmp-server" command hierarchy (at least 12 matches), including the following exemplary multi-word command(s):	"snmp-server location"
"spanning-tree" command hierarchy, including the following exemplary multi-word command(s):	"spanning-tree bpduguard"
"vrrp" command hierarchy (at least 10 matches), including the following exemplary multiword command(s):	"vrrp timers advertise"

[166] Deposition of Sadana (Rough) Tr. at 98:17:17-23 (May 27, 2016) ("Show is a keyword for many of our commands. Q. And those would be the CLI commands that are used in EOS; correct? A. That's correct.").

192. Additional examples that compare Cisco's command hierarchies illustrated visually in a tree structure compared to Arista's use of those same hierarchies in their documents are shown below:

Example 1: "aaa" hierarchy

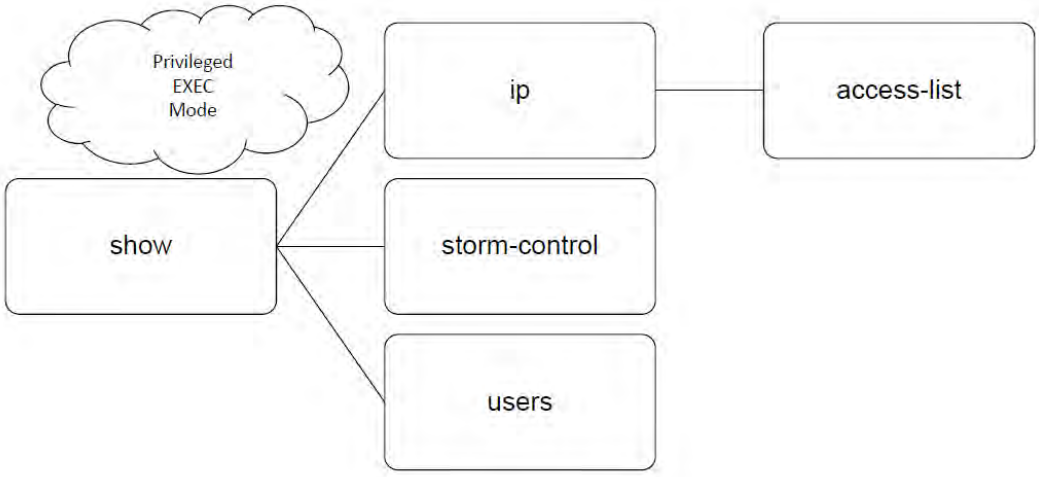


(D1, IOS Release 11.0)

AAA Configuration . . . . . .
aaa accounting 105
aaa authentication enable 106
aaa authentication login 107

(CSI-CLI-00007850, EOS 4.10.0)

Example 2: "show" hierarchy

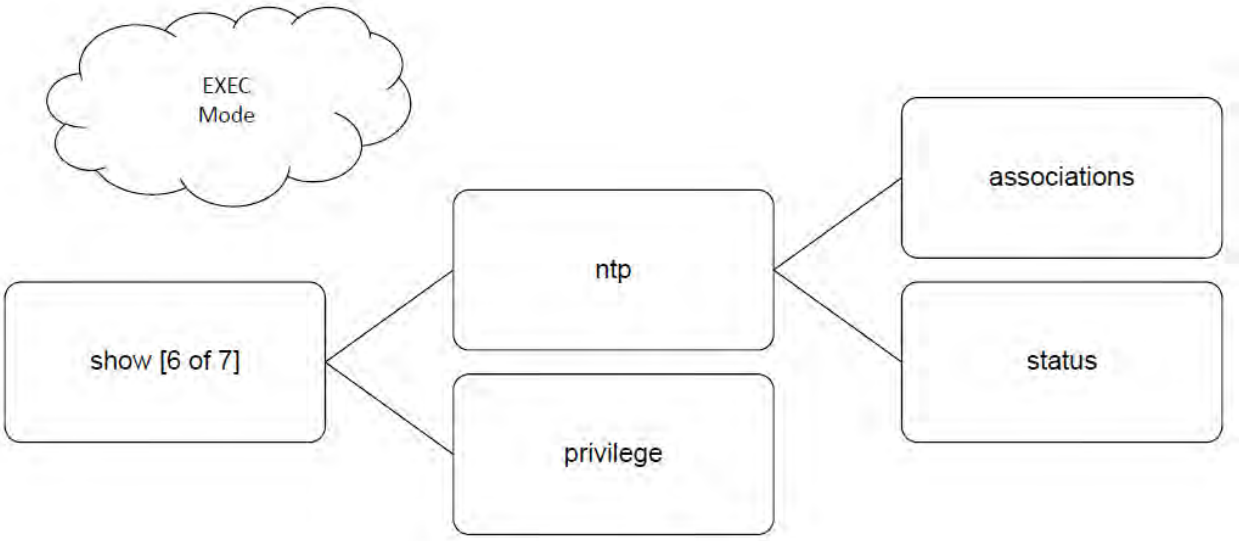


(D1, IOS Release 11.0)

show ip access-lists 470
[redacted] 471
show storm-control. 472

(CSI-CLl-00007850, EOS 4.10.0)

Example 3: another "show" hierarchy



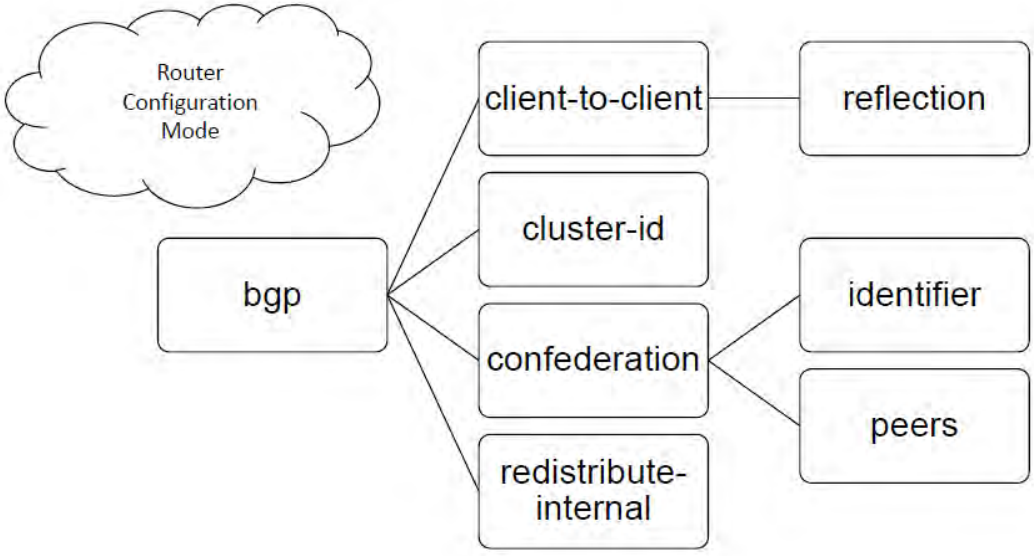
(D1, IOS Release 11.0)

show privilege 132

show ntp associations 184
show ntp status 185

(CSI-CLI-00007850, EOS 4.10.0)

Example 4: "bgp" hierarchy



(D1, IOS Release 11.0)

Border Gateway Protocol 1543
address-family 1564
aggregate-address 1565
bgp client-to-client reflection 1567
bgp cluster-id 1568
bgp confederation identifer 1569
bgp confederation peers 1570
[redacted] 1571
. 1573
. 1574
. 1575
bgp redistribute-internal (BGP) 1576

(CSI-CLI-00018146, EOS 4.14.3F)

193. Because the evidence of Arista's use of Cisco's command hierarchies is voluminous, I have summarized the similarities in Exhibit Copying-5, which is incorporated here by reference.

F. Cisco's CLI Command Responses Compared to Arista's CLI Command Responses

194. As explained above, another aspect of Cisco's CLI is the textual, screen output generated by the CLI as feedback when the user inputs a particular command. Cisco contends that in many instances, Arista provides output displays in EOS that are similar if not identical to the displays in Cisco's CLI. I agree that there are very close similarities between the screen outputs in Cisco's CLI and Arista's CLI. In some instance, in fact, it is almost impossible for a user to tell if they are using a Cisco device or an Arista device—the similarities are that close.

[redacted]

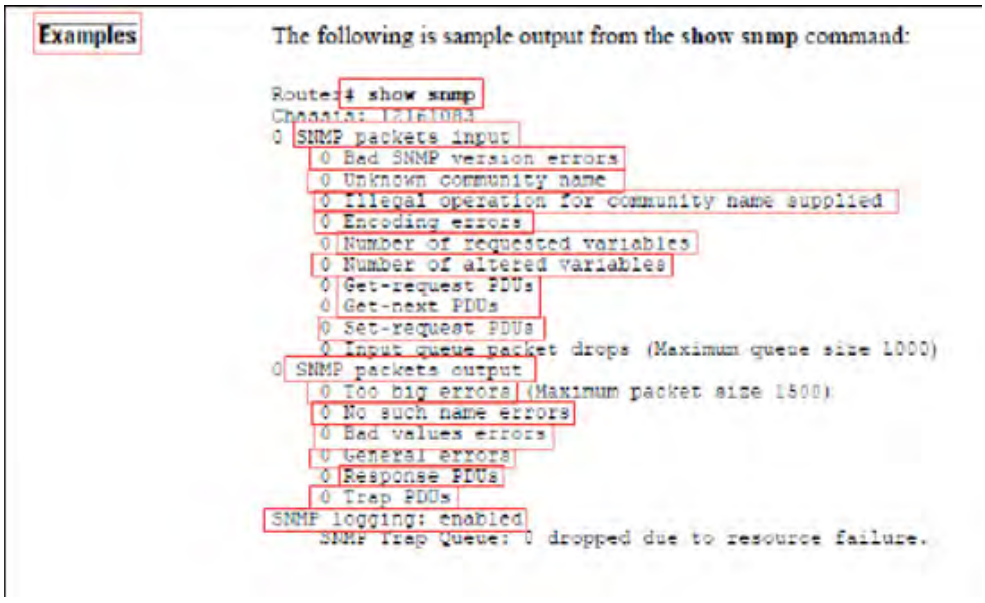
[167] Deposition of Adam Sweeney Tr. at 317:4-318:9 (Jan. 29, 2016) (emphasis added); *see also* ARISTANDCA 10508650.

[redacted]

197. This literal copying of text in the screen outputs is evident throughout Arista's EOS. For example, Cisco's Exhibit E to its interrogatory response provides a listing of command responses from Cisco's copyrighted works that Cisco's claims are identical or similar in by Arista's EOS CLI. In addition, I understand that Cisco contends that Arista has copied the non-literal elements of Cisco's command responses, including their structure, sequence and organization as also shown in Exhibit E.

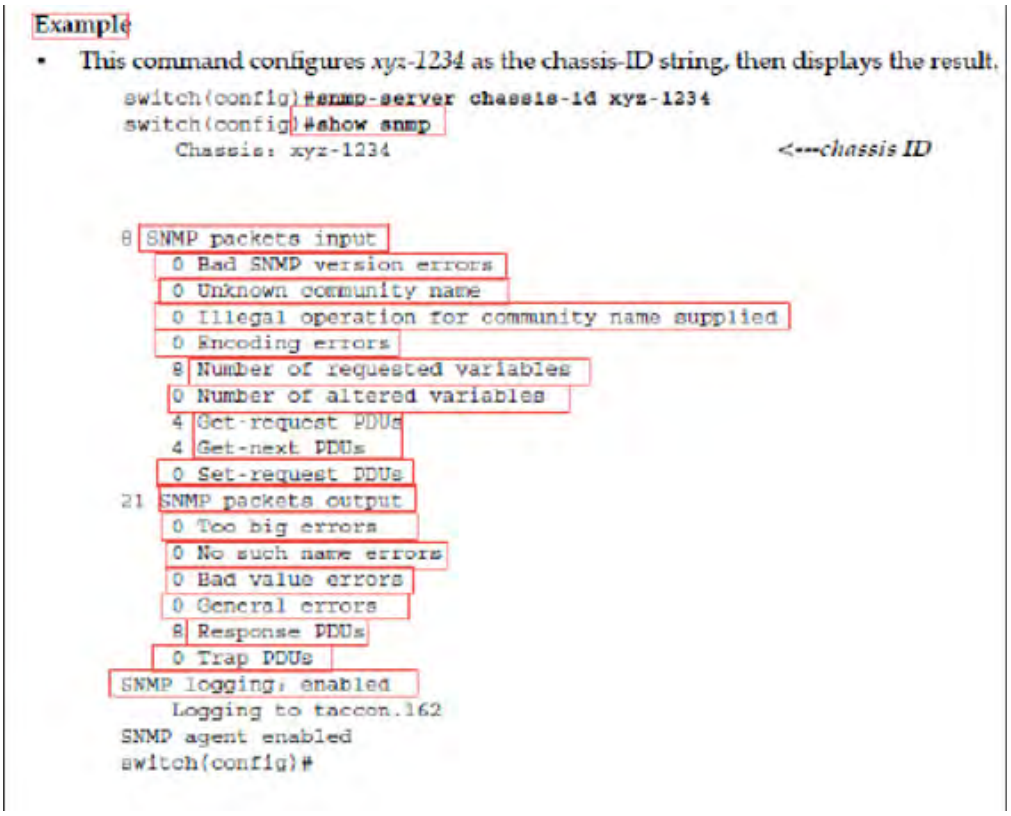
198. I have independently confirmed that the examples shown in Exhibit E exist in Arista's product documentation, and I agree that Arista's outputs are identical or similar to Cisco's.

199. For example, Cisco's CLI implements a command called "show snmp" which displays the following output (show in Cisco's product documentation):[168]



[168] CSI-CLI-00327842, Cisco IOS 15.4, Cisco IOS SNMP Support Command Reference at 83, CSI-CLI-00327934 (2013).

200. Arista's EOS also implements the "show snmp" multiword command expression and generates a similar screen, as shown below (in Arista's product documentation):[169]



Example

- This command configures *xyz-1234* as the chassis-ID string, then displays the result.

```
switch(config)#snmp-server chassis-id xyz-1234
switch(config)#show snmp
    Chassis: xyz-1234                          <---chassis ID

8 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    8 Number of requested variables
    0 Number of altered variables
    4 Get-request PDUs
    4 Get-next PDUs
    0 Set-request PDUs
21 SNMP packets output
    0 Too big errors
    0 No such name errors
    0 Bad value errors
    0 General errors
    8 Response PDUs
    0 Trap PDUs
SNMP logging: enabled
    Logging to taccon.162
SNMP agent enabled
switch(config)#
```

201. Based on my analysis, Arista's exemplary output is similar to Cisco's display for the "show snmp" command not only with respect to the text and structure but also with respect to the sequence in which these lines would appear to a user.

202. There also is evidence of similarities between the Cisco and Arista interactive "help" screens. In response to the "help" command, both Cisco's and Arista's operating systems display the following text (which was originally created by Cisco in version 9.21 of IOS):

[169] CSI-CLI-00018146, Arista User Manual v. 4.14.3F (Rev. 2) at 1967-68, CSI-CLI-00020112-13 (Oct. 2, 2014).

```
Switch>help
Help may be requested at any point in a command by entering
a question mark '?'.  If nothing matches, the help list will
be empty and you must backup until entering a '?' shows the
available options.
Two styles of help are provided:
1. Full help is available when you are ready to enter a
   command argument (e.g. 'show ?') and describes each possible
   argument.
2. Partial help is provided when an abbreviated argument is entered
   and you want to know what arguments match the input
   (e.g. 'show pr?'.)
```

(Cisco's Help Screen[170])

```
localhost#help
Help may be requested at any point in a command by entering
a question mark '?'.  If nothing matches, the help list will
be empty and you must backup until entering a '?' shows the
available options.
Two styles of help are provided:
1. Full help is available when you are ready to enter a
   command argument (e.g. 'show ?') and describes each possible
   argument.
2. Partial help is provided when an abbreviated argument is entered
   and you want to know what arguments match the input
   (e.g. 'show pr?'.)

localhost#
```

(Arista's Identical Help Screen in EOS 4.4.0[171])

[redacted] What this also evidences is that Arista copied text from Cisco's documentation into its EOS, which another form of copying.

[170] *See* Exhibit Copying-7; *see also* CSI-CLI-00540145 at CSI-CLI-00540184.

[171] *See* Exhibit Copying-7; *e.g.*, ARISTANDCA 10485839 at ARISTANDCA 10485848; see also ARISTANDCA 10485836.

[172] ARISTANDCA11406349.

204. I also have conducted testing on operational Cisco and Arista switches to confirm the similarities in the outputs that the documentation shows. In short, I have confirmed that there are numerous outputs that are similar or identical as between Cisco's IOS and Arista's EOS when running on a Cisco or Arista switch. Exemplary screen shots showing similar outputs are provided below.

205. One of the commands I tested was the "show ip route" command. Because none of the switches had any significant configuration information entered for them and because none of the switches were connected to other switches or routers there was no substantive information that could be displayed for the "show ip route" command. However, consistent with what was described in the respective manuals, a key was displayed for the type of information that would be displayed if any of the switches had been further configured. The displayed information for the Cisco 4948E is as follows:

```
Switch#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set
```

206. The version information for the Arista 7010T is as follows:

```
localhost#show ip route
Codes: C - connected, S - static, K - kernel,
       O - OSPF, IA - OSPF inter area, E1 - OSPF external type 1,
       E2 - OSPF external type 2, N1 - OSPF NSSA external type 1,
       N2 - OSPF NSSA external type2, B I - iBGP, B E - eBGP,
       R - RIP, I - ISIS, A B - BGP Aggregate, A O - OSPF Summary,
       NG - Nexthop Group Static Route

Gateway of last resort is not set
```

207. The version information for the Arista 7554 is as follows:

```
localhost(s1)#show ip route
Codes: C - connected, S - static, K - kernel,
       O - OSPF, IA - OSPF inter area, E1 - OSPF external type 1,
       E2 - OSPF external type 2, N1 - OSPF NSSA external type 1,
```

```
       N2 - OSPF NSSA external type2, B I - iBGP, B E - eBGP,
       R - RIP, I - ISIS, A B - BGP Aggregate, A O - OSPF Summary,
       NG - Nexthop Group Static Route

Gateway of last resort is not set


! IP routing not enabled
```

208. In the next example, I entered some basic configuration information for the Simple Network Management Protocol (SNMP). The configuration example was taken from an Arista manual, but it does the same thing regardless of whether the switch is a Cisco switch or an Arista switch. Configuring the switch in this way allowed me to display basic statistics about SNMP. Again, because none of the switches were connected to other switches, there were no values that had been collected. Also of note, in order to configure the SNMP server on any one of the switches I had to be in global configuration mode. I entered the global configuration mode the same way on each switch—by typing "en" for enable and then "config" to enter global configuration. The displayed information for the Cisco 4948E is as follows:

```
Switch>en
Switch#config
Configuring from terminal, memory, or network [terminal]?
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#snmp-server user tech-1 tech-sup v3
Switch(config)#exit
Switch#show snmp
Chassis: CAT1552S66E
0 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    0 Number of requested variables
    0 Number of altered variables
    0 Get-request PDUs
    0 Get-next PDUs
    0 Set-request PDUs
    0 Input queue packet drops (Maximum queue size 1000)
0 SNMP packets output
    0 Too big errors (Maximum packet size 1500)
    0 No such name errors
    0 Bad values errors
    0 General errors
    0 Response PDUs
    0 Trap PDUs
SNMP global trap: disabled
SNMP agent enabled
```

```
SNMP logging: disabled
```

209. The show snmp for the Arista 7010T is as follows:

```
localhost#config
localhost(config)#snmp-server user tech-1 tech-sup v3
localhost(config)#exit
localhost#show snmp
Chassis: HSH16130550
0 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    0 Number of requested variables
    0 Number of altered variables
    0 Get-request PDUs
    0 Get-next PDUs
    0 Set-request PDUs
0 SNMP packets output
    0 Too big errors
    0 No such name errors
    0 Bad value errors
    0 General errors
    0 Response PDUs
    0 Trap PDUs
Access Control
    0 Users
    1 Groups
    0 Views
SNMP logging: disabled
SNMP agent enabled in VRFs: default
1 warnings
! Group “tech-sup” of user “tech-1” is not configured
```

210. The show snmp for the Arista 7554 is as follows:

```
localhost(s1)>en
localhost(s1)#config
localhost(s1)(config)#snmp-server user tech-1 tech-sup v3
localhost(s1)(config)#exit
localhost(s1)#show snmp
Chassis: HSH14525015
0 SNMP packets input
    0 Bad SNMP version errors
    0 Unknown community name
    0 Illegal operation for community name supplied
    0 Encoding errors
    0 Number of requested variables
    0 Number of altered variables
    0 Get-request PDUs
    0 Get-next PDUs
    0 Set-request PDUs
0 SNMP packets output
    0 Too big errors
    0 No such name errors
    0 Bad value errors
    0 General errors
    0 Response PDUs
    0 Trap PDUs
Access Control
    0 Users
```

```
    1 Groups
    0 Views
SNMP logging: disabled
SNMP agent enabled in VRFs: default
1 warnings
! Group "tech-sup" of user "tech-1" is not configured
```

211. The next example looks at the Internet Group Management Protocol (IGMP), a protocol used to support multicast group membership registration. IGMP is considered a "snooping" protocol because switches are traditionally Layer 2 devices, but IGMP snooping requires looking at Layer 3 packets. With the "show ip igmp snooping" command, statistics about IGMP snooping are displayed. The displayed information for the Cisco 4948E is as follows:

```
Switch#show ip igmp snooping
Global IGMP Snooping configuration:
----------------------------------------
IGMP snooping                : Enabled
IGMPv3 snooping              : Enabled
Report suppression           : Enabled
TCN solicit query            : Disabled
TCN flood query count        : 2
Last Member Query Interval   : 1000

Vlan 1:
--------
IGMP snooping                        : Enabled
CAPWAP enabled                       : Disabled
IGMPv2 immediate leave               : Disabled
Explicit host tracking               : Enabled
Multicast router learning mode       : pim-dvmrp
CGMP interoperability mode           : IGMP_ONLY
Last Member Query Interval           : 1000
```

212. The show ip igmp snooping for the Arista 7010T is as follows:

```
localhost#show ip igmp snooping
    Global IGMP Snooping configuration:
----------------------------------------
IGMP snooping                  : Enabled
Robustness variable            : 2
Report flooding                : Disabled

Vlan 1 :
----------
IGMP snooping                  : Enabled
IGMPv2 immediate leave         : Enabled
Multicast router learning mode : pim-dvmrp
IGMP max group limit           : No limit set
Recent attempt to exceed limit : No
Report flooding                : Disabled
IGMP snooping pruning active   : False
```

```
Flooding traffic to VLAN       : True
```

213. The show ip igmp snooping for the Arista 7554 is as follows:

```
localhost(s1)#show ip igmp snooping
Global IGMP Snooping configuration:
----------------------------------------
IGMP snooping                  : Enabled
Robustness variable            : 2
Report flooding                : Disabled

Vlan 1 :
----------
IGMP snooping                  : Enabled
IGMPv2 immediate leave         : Enabled
Multicast router learning mode : pim-dvmrp
IGMP max group limit           : No limit set
Recent attempt to exceed limit : No
Report flooding                : Disabled
IGMP snooping pruning active   : False
Flooding traffic to VLAN       : True
```

214. The next command is used to show a wide range of information about the interfaces on the switch. The displayed information for the Cisco 4948E is as follows:

```
Switch#show interfaces FastEthernet 1
FastEthernet1 is down, line protocol is down
  Hardware is Fast Ethernet for out of band management, address is c464.1342.efbf (bia
c464.1342.efbf)
  Internet address is 10.1.1.35/24
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Unknown duplex, Unknown Speed, 100BaseTX/FX
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     0 packets input, 0 bytes
     Received 0 broadcasts (0 IP multicasts)
     0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog
     0 input packets with dribble condition detected
     0 packets output, 0 bytes, 0 underruns
     0 output errors, 0 collisions, 2 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

215. The show interfaces information for the Arista 7010T is as follows:

```
localhost#show interface ethernet 1
Ethernet1 is down, line protocol is down (notconnect)
  Hardware is Ethernet, address is 444c.a88f.f7fa (bia 444c.a88f.f7fa)
  Ethernet MTU 9214 bytes
  Auto-duplex, Auto-speed, auto negotiation: on, uni-link: unknown
  Down 35 seconds
  2 link status changes since last clear
  Last clearing of "show interface" counters never
  5 minutes input rate 0 bps (- with framing overhead), 0 packets/sec
  5 minutes output rate 0 bps (- with framing overhead), 0 packets/sec
     0 packets input, 0 bytes
     Received 0 broadcasts, 0 multicast
     0 runts, 0 giants
     0 input errors, 0 CRC, 0 alignment, 0 symbol, 0 input discards
     0 PAUSE input
     0 packets output, 0 bytes
     Sent 0 broadcasts, 0 multicast
     0 output errors, 0 collisions
     0 late collision, 0 deferred, 0 output discards
     0 PAUSE output
```

216. The show interfaces information for the Arista 7554 is as follows:

```
localhost(s1)#show interfaces Ethernet 3/1/1
Ethernet3/1/1 is down, line protocol is down (notconnect)
  Hardware is Ethernet, address is 0000.0000.0000 (bia 001c.7348.6dac)
  Ethernet MTU 9214 bytes
  Unconfigured, Unconfigured, auto negotiation: off, uni-link: unknown
  0 link status changes since last clear
  Last clearing of "show interface" counters never
  5 minutes input rate 0 bps (- with framing overhead), 0 packets/sec
  5 minutes output rate 0 bps (- with framing overhead), 0 packets/sec
     0 packets input, 0 bytes
     Received 0 broadcasts, 0 multicast
     0 runts, 0 giants
     0 input errors, 0 CRC, 0 alignment, 0 symbol, 0 input discards
     0 PAUSE input
     0 packets output, 0 bytes
     Sent 0 broadcasts, 0 multicast
     0 output errors, 0 collisions
     0 late collision, 0 deferred, 0 output discards
     0 PAUSE output
```

217. The summary of my logs and analysis in summarized in Exhibit Copying-7, which is attached hereto and incorporated by reference.

218. Because the evidence of Arista's copying Cisco's outputs is voluminous, I have summarized the similarities in Exhibit Copying-3, which is incorporated here by reference.

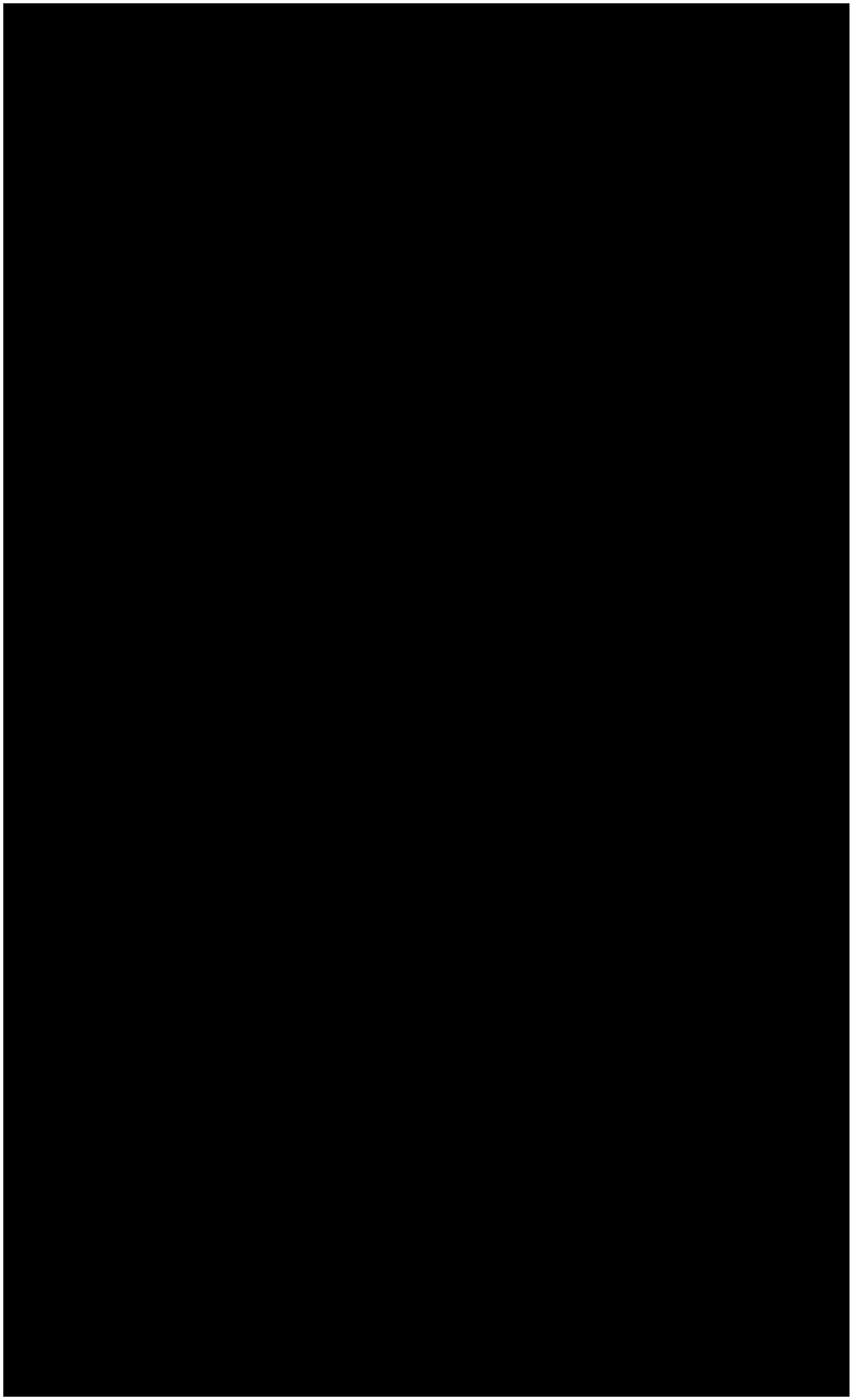
219. In addition to the similarities that Cisco and I have located, [redacted]

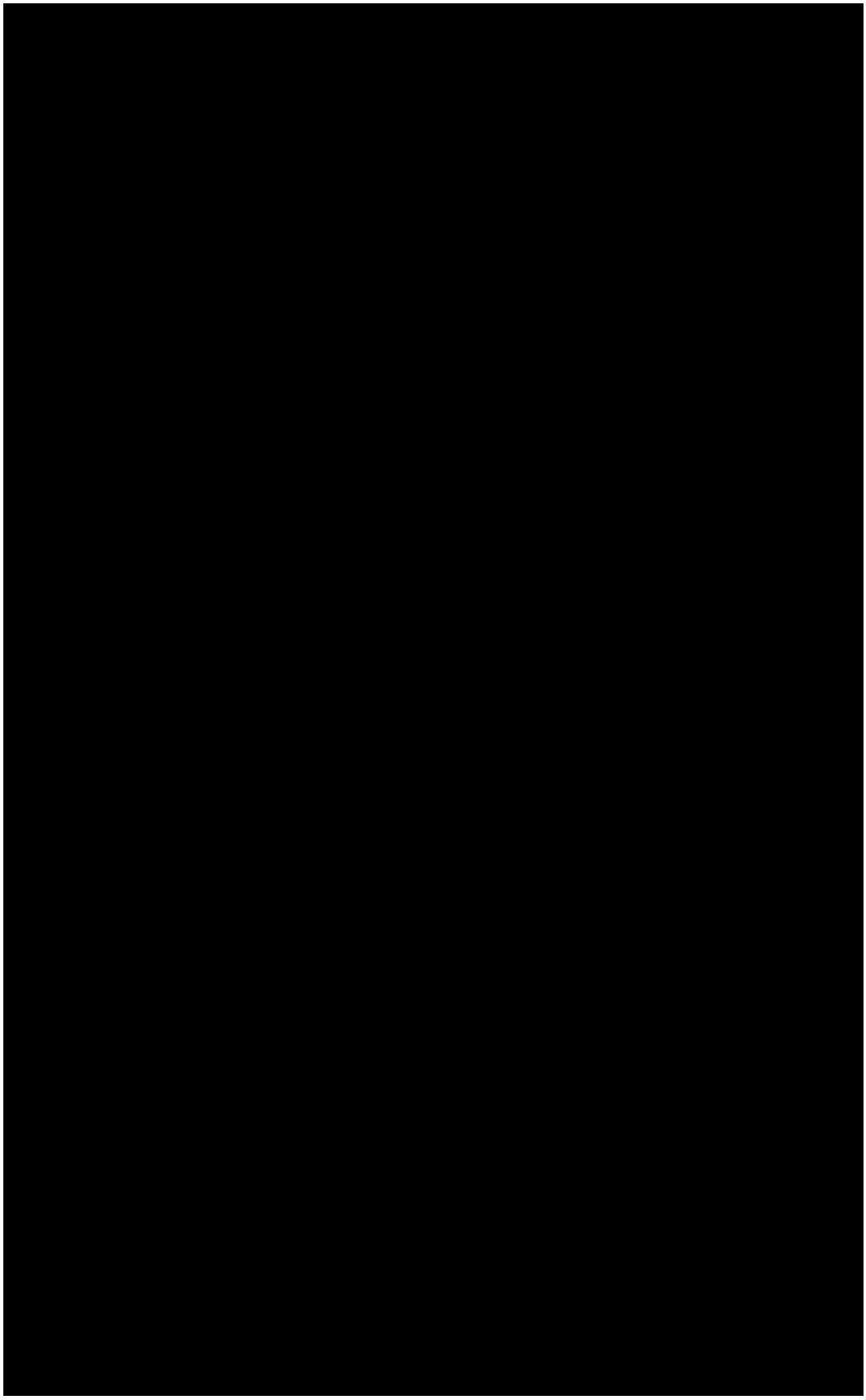
[redacted]

---

[173] ARISTANDCA12244290.

[174] ARISTANDCA1224429 to AR1STANDCA12244300.





220. [redacted]

221. Lastly, Arista's copying of the help screen displays extends to the description of various command expressions (also known as "helpdesc"). For instance, in both Cisco's CLI and Arista's CLI, users can type "?" to generate context sensitive help, including a list of available commands and descriptions thereof. Arista has copied numerous examples of Cisco's help descriptions that a user would see and these were also copied into Arista's programs. An exemplary list of the help descriptions that are similar or identical as between Cisco and IOS are listed in Exhibit Copying-6. A summary of the help descriptions is provided below in my analysis of the evidence of Arista's program copying, which is incorporated here by reference.

G. Cisco Programs Compared to the Arista Programs

222. I have personally reviewed and inspected both Arista's EOS programs and Cisco's IOS programs made available in this litigation. As part of that inspection, I have analyzed the structure and organization of the programs, as well as specific lines of code relating to the CLIs and parsers, among other relevant sections.

223. In my opinion, there are similarities between Arista's EOS programs and Cisco's IOS programs that are not, in my experience, coincidental (as I explained above). For instance, EOS was designed to recognize and process the 500+ multi-word command expressions asserted by Cisco and respond to those commands in similar ways by, ***e.g.***, producing outputs with nearly identical content and structure in some instances. In order to understand the same commands in similar ways, it is my opinion that Arista built its program with an understanding of Cisco's program and with a design goal of building a product that looks the same, feels the same, and can

be used in the same way as Cisco's. Indeed, when sitting in front of an Arista switch running EOS, it is very difficult to know whether it is a Cisco switch running IOS or and Arista switch running EOS—they are similar.

224. As I discussed above in my description of Arista's EOS programs, there are various unusual similarities between Cisco's programs and Arista's programs that suggest that, in fact, Arista developed EOS with knowledge of Cisco's program. My descriptions of those similarities above are incorporated here by reference and support my belief that despite being written in different languages Arista's EOS is similar to Cisco's IOS in significant ways (*e.g.*, the parsing structure, use of specific tokens, etc.).

225. There also is evidence of direct copying by Arista of Cisco's copyrighted works into Arista's EOS programs. I understand that Cisco provided Exhibits G and H in response to Interrogatory No. 2. Those exhibits show hundreds of command help descriptions that appear in similar or identical form in both Cisco's IOS and IOS-XR programs well as in Arista's EOS programs. Here are just a few examples taken from Exhibit G:

Cisco HelpDesc	Same or Similar Arista HelpDesc	Arista File/Line
32-bit tag value	32-bit tag value	CliPlugin/RoutingOspfCli.py:2566
48-bit hardware address of ARP entry	48-bit hardware address of ARP entry	CliPlugin/IraIpCli.py:815
A regular-expression to match hostnames	A regular-expression to match	
AAA group definitions	AAA group definitions	AaaCliLib.py:207
ARP type ARPA	ARP type ARPA	CliPlugin/IraIpCli.py:817
ASBR summary link states	ASBR summary link states	CliPlugin/RoutingOspfCli.py:3094
Summary Access List	Access list summary	CliPlugin/AclCli.py:1156
Distance metric for this route	Administrative distance for this route	CliPlugin/PimCli.py:907
Administratively shut down this neighbor	Administratively shut \ down this neighbor	CliPlugin/RoutingBgpCli.py:2145
Administratively shut down this neighbor	Administratively shut \down this neighbor	CliPlugin/RoutingBgpCli.py:2145
Advertising Router (as an IP address)	Advertising Router (as an IP address	
Advertising Router link states	Advertising Router link states	CliPlugin/RoutingOspf3Cli.py:1569
Always advertise default route	Always advertise default route	
An ordered list as a regular-expression	An ordered list as a regular-expression	CliPlugin/RouteMapCli.py:1760
Assign policy-map to the input of an interface	Assign policy-map to the input of an interface	CliPlugin/PbrCli.py:99
Assign policy-map to the output of an interface	Assign policy-map to the input of an interface	CliPlugin/PbrCli.py:99
Assign policy-map to the input of an interface	Assign policy-map to the output of an interface	CliPlugin/PbrCli.py:102
Assign policy-map to the output of an interface	Assign policy-map to the output of an interface	CliPlugin/PbrCli.py:102
authentication parameters for the user	Authentication parameters for the user	CliPlugin/SnmpCli.py:1582
encryption parameters for the user	Authentication parameters for the user	CliPlugin/SnmpCli.py:1582

(Exhibit G at 1)

Arista EOS 4.13.5: 'Specifies that an UNENCRYPTED key will follow' ->

Source Code/AaaCliLib.py:535

Cisco IOS-XR 514: 'Specifies that an UNENCRYPTED key will follow' ->

./aaa/protocols/radius/iox/radius_coa/src/cfg_dynamic_author_sub.cmd:77

./aaa/protocols/radius/iox/radius_coa/src/cfg_dynamic_author_sub.cmd:82

./aaa/protocols/radius/iox/radius_coa/src/cfg_dynamic_author_sub.cmd:141

(Exhibit H at 3)

Arista EOS 4.13.5: 'Exit from configure mode' ->
Source Code/BasicCli.py:1058
Cisco IOS-XR 514: 'Exit from configure mode' ->
./parser/src/preload_admin_mode.cmd:29
./parser/src/preload_admin_mode.cmd:34
./parser/src/preload_admin_mode.cmd:40
./parser/src/preload_admin_mode.cmd:45
./parser/src/preload_config_mode.cmd:35
./parser/src/preload_config_mode.cmd:40
./parser/src/preload_config_mode.cmd:46
./parser/src/preload_config_mode.cmd:51

(Exhibit H at 5)

Arista EOS 4.13.5: 'Copy from current system configuration' ->
Source Code/CliPlugin/FileCli.py:54
Cisco IOS-XR 514: 'Copy from current system configuration' ->
./shellutil/src/copy_admin.cmd:23
./shellutil/src/copy_admin.cmd:38

(Exhibit H at 18)

226. I have reviewed Exhibits G and H, and I have independently confirmed their content. Based on my review of these help descriptions, it is my opinion that the help descriptions are similar and in many instances word-for-word identical. In other words, there is evidence that Arista copied over 500 multi-word help descriptions from Cisco into its programs, and in doing so copied portions of Cisco's programs.

227. I also performed testing to confirm these findings, and found evidence of copying as well. For example, he follow screen shots show similarities between the help descriptions output with "show ?":

```
localhost>show ?
  arp                 ARP table
  boot-extensions     Contents of boot extensions configuration
  clock               Display the system clock
  diagnostic          Show diagnostic tests
  dot1q-tunnel        Show all enabled dot1q-tunnel ports
  environment         Show environment status
  errdisable          Show errdisable information
  error               Show detailed information about an earlier error
  extensions          EOS extensions present on this device
  flowcontrol         Show interface flowcontrol information
  history             Display the session command history
  installed-extensions Installed EOS extensions
  interfaces          Interface status and configuration
  inventory           Display hardware inventory with serial numbers
  ip                  IP information
  lacp                Link Aggregation Control Protocol (LACP) status
  lldp                Show Link Layer Discovery Protocol (LLDP) status
  logging             Show the contents of logging buffers
  mac-address-table   MAC forwarding table
  mlag                MLAG status
  monitor             Mirroring information
  ntp                 Network Time Protocol
  port-channel        port-channel status
  privilege           Display the current privilege level
  processes           Show cpu and memory usage of running processes
  radius              RADIUS server attributes
  reload              Display system reload status
  sflow               sFlow configuration
  snmp                SNMP statistics
  spanning-tree       Spanning tree topology
  tacacs              TACACS+ server attributes
  uptime              Show how long the system has been running
  version             Show switch version information
  vlan                Show VLAN status
```

(Arista)

```
Switch>show ?
  aaa                 Show AAA values
  adjacency           Adjacent nodes
  arp                 ARP table
  auto                Show Automation Template
  cca                 CCA information
  class-map           Show QoS Class Map
  clock               Display the system clock
  cns                 CNS agents
  controllers         Interface controller status
  crypto              Encryption module
  dampening           Display dampening information
  diagnostic          Show command for diagnostic
  dot1q-tunnel        Display dot1q tunnel ports
  dot1x               Dot1x information
  eigrp               EIGRP show commands
  env                 Environmental facilities
  epm                 EPM information
  errdisable          Error disable
  etherchannel        EtherChannel information
  exception           exception informations
  flash:              display information about flash: file system
  flowcontrol         show flow control information
  format              Show format information
  history             Display the session command history
  hosts               IP domain-name, lookup style, nameservers, and host table
  idprom              show IDPROMs for interfaces
  if-mgr              if-mgr information
  inventory           Show the physical inventory
  ip                  IP information
  ipc                 Interprocess communications commands
  ipv6                IPv6 information
  kerberos            Show Kerberos Values
  kron                Kron Subsystem
  l2                  Layer 2
  l2protocol-tunnel   Display L2PT status and configurations
  lacp                Port channel information
  link                Show Link
  lldp                LLDP information
  location            Display the system location
  login               Display Secure Login Configurations and State
  mab                 MAB information
  mac                 MAC configuration
  macro               Show command macros
  memory              Memory statistics
  mls                 mls global commands
  monitor             Monitoring different system events
  network-policy      Network Policy profile information
  odm-format          Show the schema used for ODM input file
  pagp                Port channel information
  platform            platform specific show commands
  pm                  Show Port Manager commands
  policy-map          Show QoS Policy Map
  power               Switch Power
  queue               Show queue contents
  queueing            Show queueing configuration
  radius              Shows radius information
  resource            Resource group statistics
  rmon                rmon statistics
  sasl                show SASL information
  sessions            Information about Telnet connections
  shell               Display shell information
  snmp                snmp statistics
  ssh                 Status of SSH server connections
  ssl                 Show SSL command
  storm-control       Show storm control configuration
  table-map           Show Table Map
  tacacs              Shows tacacs+ server statistics
  template            Template information
  terminal            Display terminal configuration parameters
  time-range          Time range
  udld                UDLD information
  users               Display information about terminal lines
  version             System hardware and software status
  vlan                VTP VLAN status
  vmps                VMPS version information
```

(Cisco)

228. The follow screen shots show similarities between the help descriptions output with "show interface ?" :

```
localhost>show interface ?
  Ethernet       Ethernet interface
  Loopback       Loopback interface
  Management     Management interface
  Port-Channel   Port-Channel Interface
  Vlan           Vlan interface
  capabilities   Show interface capabilities information
  counters       Interface counters
  description    Show interface description
  flowcontrol    Show interface flowcontrol information
  negotiation    Show interface Auto-Negotiation status
  phy            Display low-level PHY status
  status         Show interface line status
  switchport     Show interface switchport information
  transceiver    Show interface transceiver
  vlans          Show interface VLAN information
  |              Output modifiers
  <cr>
```

(Arista)

```
Switch>show interface ?
  Async                 Async interface
  Auto-Template         Auto-Template interface
  BVI                   Bridge-Group Virtual Interface
  CTunnel               CTunnel interface
  Dialer                Dialer interface
  FastEthernet          FastEthernet IEEE 802.3
  Filter                Filter interface
  Filtergroup           Filter Group interface
  GigabitEthernet       GigabitEthernet IEEE 802.3z
  GroupVI               Group Virtual interface
  Loopback              Loopback interface
  Null                  Null interface
  Port-channel          Ethernet Channel of interfaces
  Portgroup             Portgroup interface
  Pos-channel           POS Channel of interfaces
  Tunnel                Tunnel interface
  Vif                   PGM Multicast Host interface
  Virtual-Template      Virtual Template interface
  Virtual-TokenRing     Virtual TokenRing
  Vlan                  Catalyst Vlans
  accounting            Show interface accounting
  capabilities          Show interface capabilities information
  counters              Show interface counters
  crb                   Show interface routing/bridging info
  dampening             Show interface dampening info
  debounce              Show interface debounce time info
  description           Show interface description
  etherchannel          Show interface etherchannel information
  fair-queue            Show interface Weighted Fair Queueing (WFQ) info
  fcpa                  Fiber Channel
  flowcontrol           Show interface flowcontrol information
  irb                   Show interface routing/bridging info
  mac-accounting        Show interface MAC accounting info
  mpls-exp              Show interface MPLS experimental accounting info
  mtu                   Show interface mtu
  precedence            Show interface precedence accounting info
  private-vlan          Show interface private vlan information
  pruning               Show interface trunk VTP pruning information
  random-detect         Show interface Weighted Random Early Detection (WRED)
info
  rate-limit            Show interface rate-limit info
  stats                 Show interface packets & octets, in & out, by
switching
                        path
  status                Show interface line status
  summary               Show interface summary
  switchport            Show interface switchport information
  transceiver           Show interface transceiver
  trunk                 Show interface trunk information
  |                     Output modifiers
```

(Cisco)

229. The follow screen shots show similarities between the help descriptions output with "show ip ospf ?":

```
Arista
------
localhost(s1)#show ip ospf ?
  border-routers        Border routers
  database              Database summary
  interface             Interface information
  lsa-log               LSA throttling Log
  neighbor              Neighbor information
  request-list          Request list
  retransmission-list   Re-transmission list
  spf-log               Spf Log
  vrf                   VRF name
  <1-65535>             Process ID
  >                     Redirect output to URL
  >>                    Append redirected output to URL
  |                     Output modifiers
  <cr>
```

(Arista)

```
Switch>show ip ospf ?
  <1-65535>          Process ID number
  border-routers     Border and Boundary Router Information
  database           Database summary
  interface          Interface information
  max-metric         Max-metric origination information
  mpls               MPLS related information
  neighbor           Neighbor list
  sham-links         Sham link information
  statistics         Various OSPF Statistics
  summary-address    Summary-address redistribution Information
  timers             OSPF timers information
  traffic            Traffic related statistics
  virtual-links      Virtual link information
  |                  Output modifiers
  <cr>
```

(Cisco)

230. Because the evidence of Arista's reproduction of Cisco's help descriptions into EOS is voluminous, I have summarized the similarities in Exhibit Copying-6, which is incorporated here by reference.

VII. THERE IS NO INDUSTRY STANDARD FOR CISCO'S COPYRIGHTED WORKS

231. I understand that Arista contends that it is permitted to use Cisco's IOS CLI because Cisco's IOS is an "industry standard." As explained below, I disagree with Arista and

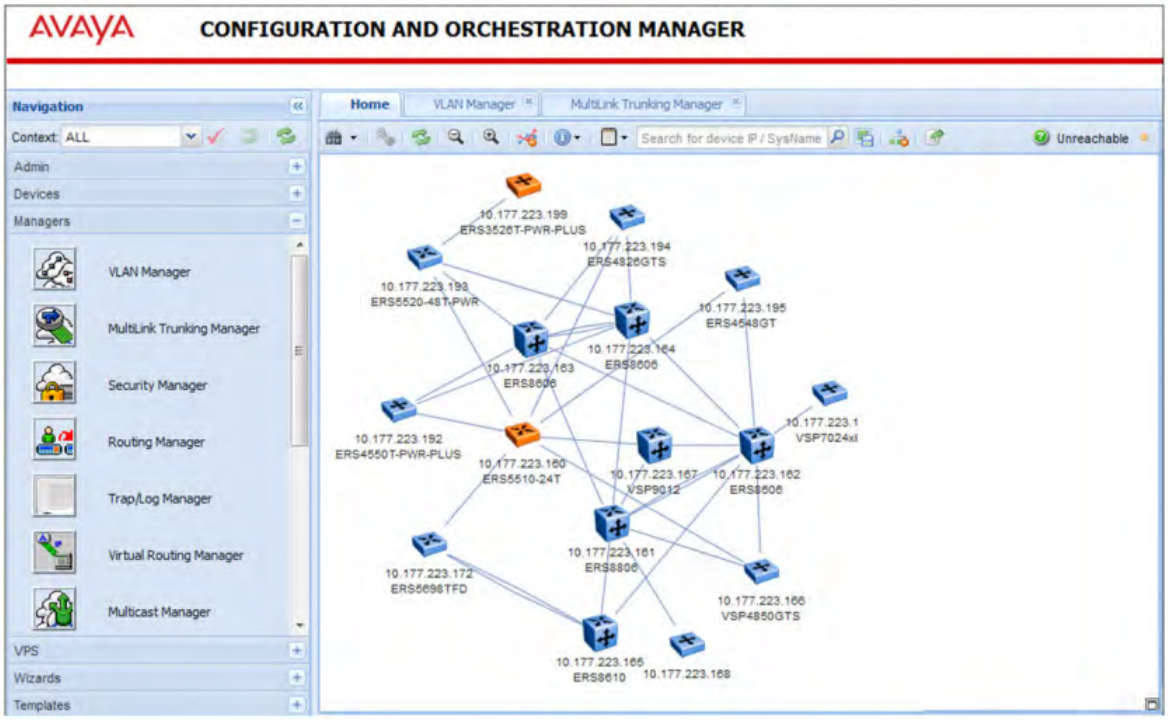
have seen to actual evidence that Cisco's IOS CLI or its copyrighted works are part of any industry standard.

232. When Cisco was founded in the mid-1980s, the router industry still was in its infancy; accordingly, there were no standards or constraints that required Cisco to choose a particular type of computer program for its products. There also was no clear consensus in the industry on which type of computer program was preferred. Thus, from the beginning of the design process, Cisco's engineers were faced with the fundamental creative question of what type of computer program to implement. And there were a broad range of options open to them, including but not limited to a command line interface (*e.g.*, DOS or UNIX), a graphical user interface, and a menu-driven interface, among others.

233. I have discussed the first computer program—the command line interface—in great detail already and so I will not repeat an explanation of that interface here.

234. A second type of computer program available to Cisco was a graphical user interface or "GUI." A GUI uses graphical symbols and icons to facilitate communication between the user and the router. Typically, a GUI includes windows, buttons and menus that can be accessed using a mouse. Each button and each option listed on the pull-down menus correspond to one or more functions that can be performed by the router. When a user clicks on a button or selects one of the menu options the router performs the functions associated with that button or menu option. Once of Cisco's competitors, Avaya, utilizes a graphical user interface for its routers,[175] for example:[176]

[175] *See, e.g.*, https://www.avaya.com/usa/documents/avaya-ethernet-routing-switch-3500-series-lb7028.pdf ("For customers who are looking for a simple Graphical User Interface (GUI) for management and provisioning, Avaya's Enterprise Device Manager (EDM) is an embedded web-based element management and configuration tool that enables set-up, configuration and monitoring of a single device using either HTTP or HTTPS (Secure Web)");



235. A menu driven computer program presents the user with a series of menus, each of which lists several functions that can be performed by the router. Unlike a graphical user interface, a menu-driven computer program is usually all text, with no graphical symbols or icons. When the user selections one of the options listed on the menu (by pressing a letter or number corresponding to the function) the router either performs the appropriate functions and/or presents the user with additional menus that permit the user to provide more detailed instructions.

236. CLIs, GUIs, and menu-driven computer program all have been widely used since the original development of routers in the mid-1980s and remain in use today, by way of

---

see also https://www.avaya.com/usa/documents/avaya-ethernet-routing-switch-4000-series-dn4814.pdf.

[176] *See* http://www.avaya.com/usa/product/configuration-and-orchestration-manager/.

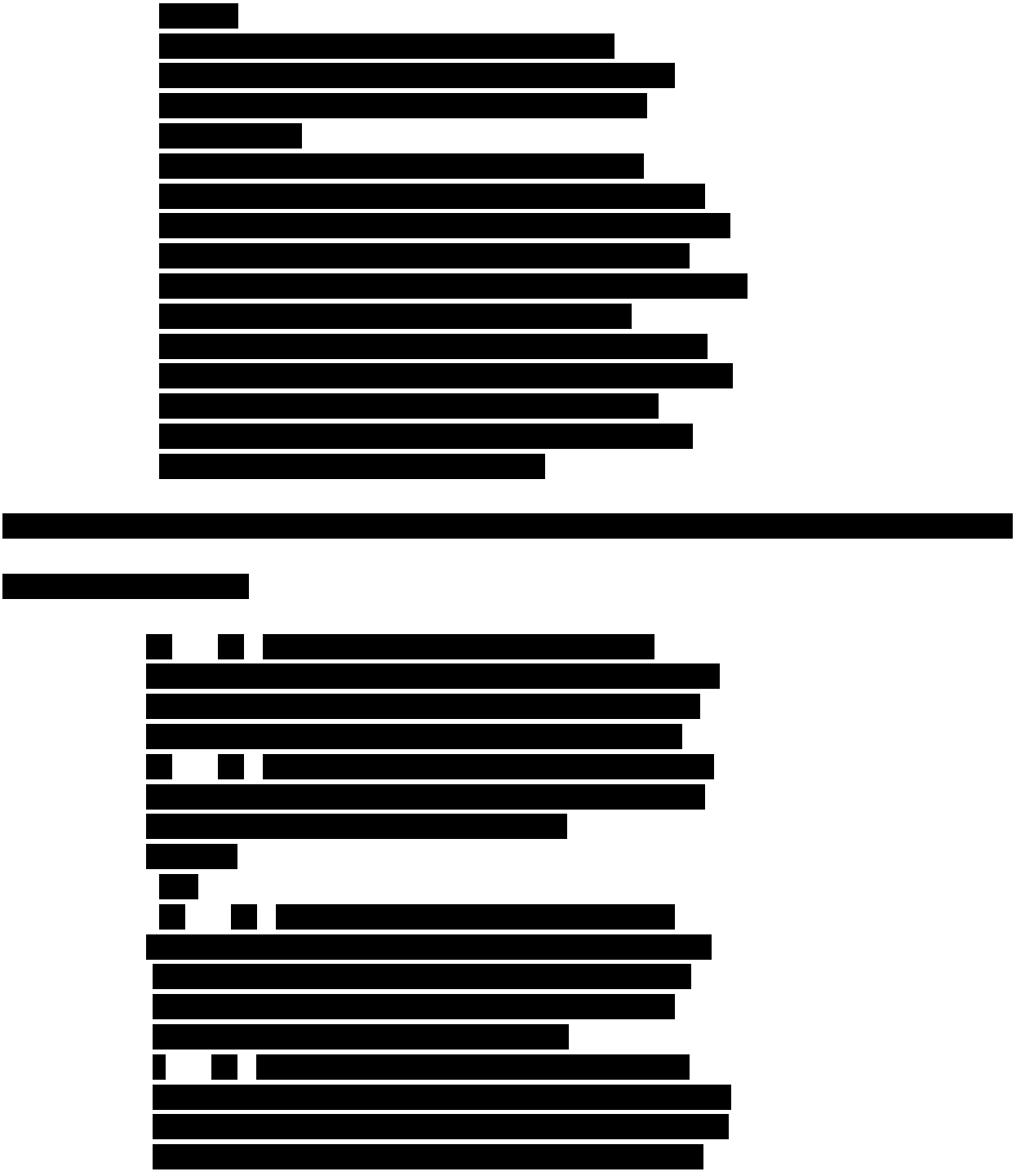
example only (this is not meant to be an exhaustive list), Avaya has used a GUI,[177] 3Com has used a menu-drive interface programs,[178] and Juniper (as discussed herein) as well as other competitors in the market used CLI programs.

[redacted]

[177] https://downloads.avaya.com/css/P8/documents/100128482 ((“The Configuration and Orchestration Manager (COM) is also a GUI”)

[178] http://h10032.www1.hp.com/ctg/Manual/c02608750 (the equivalent Web Interface menu”).

[179] Sean Hafeez Deposition Tr. at 67:8-11 (“Q. Now, you would agree with me, though, that there are different CLIs that are available to customers, right? A. Yes.”).



[redacted]

> [redacted]

[redacted] [redacted]

> [redacted]

[180] Deposition of Sadana (Rough) Tr. at 176:18-177:5 (May 26, 2016); *see also* Deposition of Sadana (Rough) Tr. at 98:25-99:8 (discussing Linux commands).

[redacted]

[redacted]

[redacted]

[redacted]

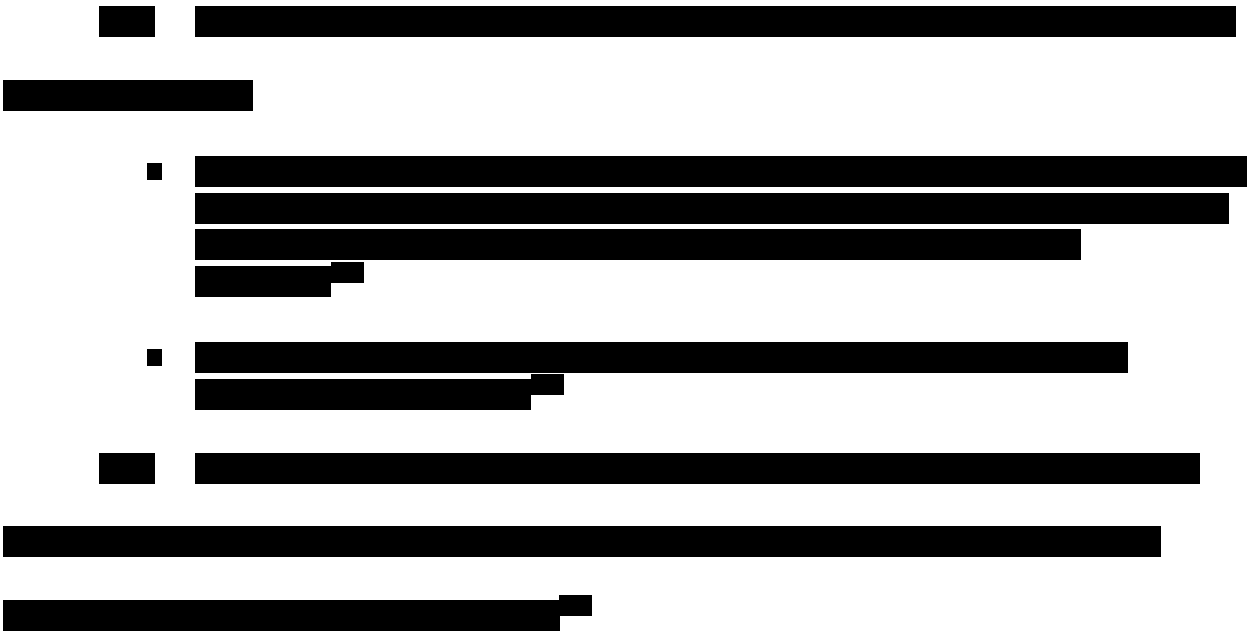
[redacted]

239. Mr. Sweeney also conceded that Juniper's CLI is a "fundamentally different structure" than what he considers to be the so-called "industry standard":

156:12 A. Industry standard looks—you typically
156:13 have a lot more, say, on a single line. It's a little
156:14 harder to describe when you -- unless you're looking
156:15 at it, but, where Junos tends to break things up more

156:16 hierarchically, so they use—it's just a
156:17 fundamentally different structure. If—if you know
156:18 the standard words, you can decipher what they're
156:19 doing, but the way they lay it out is—is different.

Deposition Testimony of Adam Sweeney at 156:12-19 (May 13, 2016).



242. In fact, Cisco itself offers a CLI—NX-OS—that is not, according to Arista, an industry standard CLI. Arista's Mr. Sadana testified that NX-OS has "commands that are unique or different with the[] operating system" and they "they're different than what the industry standard commands would be."[184] And, in Arista's opinion, even though Arista views NX-OS as "lipstick on a pig,"[185] I have found evidence that EOS implements 40 multi-word commands

[181] ANI-ITC-944_945-3937682.

[182] ARISTANDCA1195413.

[183] CSI-CLI-00540078 at CSI-CLI-00540079 ("Of course, you don't have to use our CLI if you don't want to").

[184] Deposition of Sadana (Rough) Tr. at 184:18-185:7 (May 26, 2016); *see also* Exhibit 1202.

[185] Deposition of Sadana (Rough) Tr. at 186:17-24 (May 26, 2016); *see also* Exhibit 1202.

from NX-OS that are not in IOS (in other words, they have copied Cisco multi-word command expression that even Arista itself does not believe are "industry standard"):

NX-OS Commands
class-map type control-plane
clear ip arp
clear spanning-tree counters
ip igmp startup-query- interval
ip msdp group-limit
ip pim anycast-rp
ip pim bfd-instance
isis passive
isis passive interface
mac access-list
policy-map type control- plane
priority-flow-control mode
ptp domain
ptp sync interval
show hostname
show ip msdp mesh-group
show ipv6 bgp
show ipv6 bgp neighbors
show ipv6 bgp summary
show lacp interface
show lacp neighbor
show policy-map interface control-plane
show port-channel summary
show port-channel traffic
show ptp clock
show ptp parent
show ptp time-property
show role
show snmp source-interface
show snmp trap
show spanning-tree blockedports
show spanning-tree bridge
show spanning-tree interface
show spanning-tree root
show user-account
show vlan private-vlan

show vlan summary
spanning-tree bridge assurance
statistics per-entry
username sshkey

243. I also have found evidence that Arista implements at least 11 additional multi-word command expressions that are not used by IOS but are from one of Cisco's other operating systems (IOS-XR, IOS-XE, NX-OS). This further proves that Arista's copying of Cisco goes beyond even what it contends to be "industry standard" elements:

Other Cisco OS Except IOS
interface ethernet
ip dhcp smart-relay global
log-adjacency-changes (IS- IS)
policy-map type qos
show environment power
show isis interface
show lacp counters
show mac address-table count
show port-security interface
show radius
show spanning-tree mst interface

244. Arista's interrogatory response to Cisco's Interrogatory No. 10 further confirms that there is a lot of diversity in command and mode choice and use in the industry.[186] Indeed, what Arista's own analysis shows is that some industry participations—like IBM—do not use any of the so-called "industry standard" multi-word commands that Arista copied from Cisco and that many participates use their own modes/prompts as well:

[186] I have assumed for purposes of this report only that Arista's response to Interrogatory No. 10 is accurate.

Company	**Interrogatory No. 10 Mode/Prompt**	**Interrogatory No. 10 Command Overlap**
Adtran	1	178
Alcatel/Alcatel Lucent	4	140
Allied Telesis (formerly Allied Telesyn)	4	102
Aruba	0	5
Avaya	4	99
Bay Networks	0	2
Brocade Communications Systems	4	245
Checkpoint Technologies	0	74
Darkstar/XKL	0	33
D-link Corporation	4	305
Digital Equipment Corporation	0	5
Dell	4	270 (Arista included Force 10 with Dell)
Edge-core Networks	4	221
Ericsson	4	164
Enterasys Networks (now owned by Extreme Networks)	0	22
Extreme Networks	4	95
F5 Networks	4	24
Force 10	4	See Dell
Foundry	4	165
HP	4	131 (HP and/or 3COM
IBM	4	0
ISCLI (including Blade Networks, IBM, and NEC products that support ISCLI)	0	107
Juniper JUNOSe	--	209
Juniper JUNOS	4	25
NextHop Technologies	--	223
Netgear	4	158
Nortel	4	0
Perle	4	29
Procket	0	104
RedBack Networks	--	66
Sun Microsystems	4	130 (and/or Oracle)

245. Further, even though the term "industry standard" may be used by some in the industry when marketing their products for different context, there is, in fact, no industry standard command line interface computer program let alone an industry standard for the Cisco CLI.[187] Based on my review of the evidence and knowledge of the industry, I have seen no evidence that Cisco's CLI is part of an industry standard. Industry standard protocols typically specify how data is sent from device-to-device—they do not specify implementation choices by vendors, including user interfaces, command selection, command hierarchical relationships, documentation, or screen outputs, which are influenced by subjective vendor preferences. Thus, it does not surprise me that there is no industry standard for Cisco's copyrighted works. Not only is there diversity in the multi-word command expressions, there is diversity in the help screens, outputs, and other display screens.

246. Moreover, the evidence I have reviewed from Arista, Cisco, and third parties consistently shows that there is no industry standard CLI (one aspect of Cisco's copyrighted works). Numerous Arista executives and engineers have confirmed that there is no "industry standard" CLI.[188] Former Arista employees also have confirmed that that it is certainly possible

---

[187] *See, e.g.*, Cisco's responses to Arista's Interrogatory No. 9.

[188] *See, e.g.*, Deposition Testimony of Jayshree Ullal (Arista President & CEO) at 68:14-69:4, 208:7-210:16, 217:11-21, 223:12-19; Deposition Testimony of Kenneth Duda (Arista CTO & SVP of Software Engineering) at 58:8-59:24, 70:4-17, 73:23-75:16, 93:20-95:2, 195:18-197:8, 323:22-324:19, 326:6-329:11; Deposition Testimony of Anshul Sadana (Arista SVP of Customer Engineering) at 93:20-103:4, 281:12-20, 108:17-109:4, 242:17-247:19, 267:2-271:24, 272:24-273:5; Deposition Testimony of Adam Sweeney (Arista VP of Software Engineering) at 257:12-17, 159:9-160:9, 161:8-16, 161:25-162:7, 163:12-164:2, 165:1-6; Deposition Testimony of Lincoln Dale (Arista Distinguished Engineer) at 272:20-274:24, 215:23-216:7, 216:14-217:4, 222:4-13; Deposition Testimony of Hugh Holbrook (Arista VP of Software Engineering) at 84:13-17, 147:25-148:13, 248:8-12; Deposition Testimony of Mark Foxx (Arista SVP of Global Operations & Marketing) at 100:10-12, 100:23-101:2, 112:11-13; Deposition Testimony of Berly Tr. at 140:25-141:3; Deposition Testimony of Lorenz Redlefsen Tr. at 40:1-9; Deposition Testimony of Dale Deposition; Deposition Testimony of Bechtolsheim; Deposition Testimony of Lang; Deposition Testimony of Berly; Deposition Testimony of Giancarlo; Deposition

to deviate from some of the more popular CLIs in the industry,[189] and that in certain instances Arista has deviated from those CLIs, suggesting that it would have been possible for Arista to implement its own unique CLI.[190] Arista's CEO confirmed that other alternatives are available to Cisco's IOS CLI as well. For example, Arista's CEO testified that Cisco had developed graphical user interfaces for its Catalyst products, which allowed customers to view and configure a switch.[191] These GUIs were called VLAN, Cisco View, and CWSI and are all different from Cisco's IOS CLI.

247. Additionally, I have seen no evidence to suggest that Cisco ever proposed its CLI to a standards-setting body[192] or that Cisco requires others in the industry to use its CLI. According to Cisco, when the term "industry standard" is used in Cisco's marketing materials, it refers to "the popularity and quality of Cisco's CLI in Cisco's industry leading products."[193] It does not refer to an industry standard adopted by an industry standard setting organization, such as the IEEE and IETF.[194] I have independently confirmed this to be true—neither the IEEE nor the IETF has adopted Cisco's CLI as a standard. And I have seen no evidence from Arista that any other standard setting body adopted Cisco's CLI as a standard. I also have not seen any

---

Testimony of Foss; Deposition Testimony of Hull; Deposition Testimony of Pech; Deposition Testimony of Redlefson; Deposition Testimony of Sollender; *see also* the deposition testimony identified in response to Arista's Interrogatory No. 21, which is incorporated here by reference.

[189] Sean Hafeez Deposition Tr. at 78:20-25 (Q. "Do you agree with him that there are opportunities to deviate from the standard, yes or no? … THE WITNESS. Yes.").

[190] Sean Hafeez Deposition Tr. at 79:23-80:7.

[191] Jayshree Ullal Deposition Tr. at 96:4-98:5.

[192] *See, e.g.*, Deposition Testimony of Lang, Bechtolsheim, Berly, Ullal; *see also* the deposition testimony identified in response to Arista's Interrogatory No. 21, which is incorporated here by reference.

[193] *See, e.g.*, Cisco's responses to Arista's Interrogatory No. 9.

[194] *See, e.g.*, Cisco's responses to Arista's Interrogatory No. 9.

evidence to suggest that Cisco has given any competitors permission to copy or to use substantial portions of its CLI.[195]

248. Furthermore, as it relates to the screen displays, command descriptions, and documentation that Arista has copied, I have not seen any allegation by Arista that those particular elements are in any way "industry standard." In fact, Arista's definition of the term "industry standard" mentions none of those elements:

> "The term 'industry standard CLI' refers to CLI commands, and the attendant command modes, prompts, and hierarchies, that are widely recognized and supported by other networking vendor CLIs regardless of whether they are used by Cisco across all of its various operating systems. The 'industry standard CLI' also means the CLI commands and attendant CLI functionality that most customers—and in particular, most end-users who interact with the networking equipment—are most familiar with, have used for years, and have invested time and resources to learn."[196]

249. Even assuming for the sake of argument that the elements Arista lists are part of some "industry standard"—commands, modes, prompts, hierarches, functions—it is not disputed by Arista that the many other elements of Cisco's copyrighted works that Arista copied do not even fall within Arista's definition of "industry standard." Accordingly, Arista has not made any "industry standard" argument for its copying of at least Cisco's screen displays, help descriptions, command descriptions, and documentation.

250. The fact that certain Arista documents also use the term "industry standard" does not change my opinion. [redacted]

[195] *See, e.g.*, Deposition Testimony of Jiandani, Roy, and Lang (7/31/15).

[196] Arista's response to Cisco's Interrogatory No. 24.

[197] ARISTANDCA1195413.

Another Arista engineer, Lincoln Dale, gave a presentation at a QuestNet Conference in July 2013 where he unequivocally said that Arista's use of the term "industry standard" was a "joke": "We say that our switches run an industry standard CLI. I guess that's my joke for say it's the same as IOS."

251. Furthermore, Arista's CTO testified that his definition of industry standard is something that is "generally" or "widely" practiced in the industry.[198] Mr. Duda further could not even identify a single example of changing a CLI command that could cause Arista to "lose compliance with a standard formally adopted by an industry standard setting body."[199]

252. Finally, I understand that Cisco contends that the use of Cisco's CLI is not a requirement for networking interoperability.[200] I agree. As I stated above, there is nothing about a CLI—let alone Cisco's CLI—that relates to the implementation of networking protocols or the ability of devices from different vendors to communicate and interact with each other. Numerous Arista witnesses have confirmed that CLIs are not required for interoperability in the industry.[201] Furthermore, Arista executive Anshul Sadana testified that it was entirely possible to have different CLIs for standard industry protocols:[202]

---

[198] Deposition of Kenneth Duda Tr. at 63:2-9, 94:14-25 (Feb. 12, 2016).

[199] Deposition of Kenneth Duda Tr. at 75:5-16 (Feb. 12, 2016).

[200] Cisco's Response to Arista Interrogatory No. 21 at 13-14.

[201] Deposition Testimony of Jayshree Ullal (Arista President & CEO) at 253:14-254:7, 276:10-277:16, 304:12-307:24; Deposition Testimony of Kenneth Duda (Arista CTO & SVP of Software Engineering) at 143:2-145:3, 145:4-151:9, 159:15-23, 176:16-177:17, 350:7-351:6; Deposition Testimony of Anshul Sadana (Arista SVP of Customer Engineering) at 51:14-18, 70:24-74:8, 230:24-25; Deposition Testimony of Adam Sweeney (Arista VP of Software Engineering) at 223:17-224:12, 175:15-23, 217:12-218:8; Deposition Testimony of Lincoln Dale (Arista Distinguished Engineer) at 231:5-17, 186:14-187:7, 193:1-25, 194:14-195:2, 195:7-196:2, 267:13-268:5, 271:18-25, 272:11-19; Deposition Testimony of Hugh Holbrook (Arista VP of Software Engineering) at 224:7-19, 241:4-22, 243:6-244:17.

[202] Anshul Sadana Deposition Tr. at 71:10-21.

Q. It's possible, sir, that you could have two switches with different CLI commands for the same network protocol and still interoperate?
MR. FERRALL: Objection. Vague and ambiguous.
THE WITNESS: You could have a different CLI for protocols that are standardized, and you can connect the two and make it work. But you're talking about protocol interoperability only, there are many other pieces related to network operations where the context and the discussion may be different.

253. In sum, it is my opinion that the evidence does not show that there is any industry standard CLI let alone that Cisco's IOS CLI in an industry standard CLI.

VIII. CONTRIBUTORY INFRINGEMENT & VICARIOUS LIABILITY

254. I understand that Cisco contends that Arista also has contributed to the infringement of others, including its distributors and customers. It is my understanding that contributory infringement requires third party copying, knowledge by the defendant, and material contribution or inducement.

255. Arista's EOS and its related-documents copy original expressions from Cisco's IOS copyright works, as discussed in detail above.

256. I conclude that Arista strongly encourages its customers to use Arista products incorporating EOS—as well as Arista user manuals and guides that Arista admits it supplies[203]—for reproduction and distribution on their devices. Arista provides products, programs, and technical support so that its distributors and/or customers may use Arista's EOS and/or EOS+ operating systems and its command-line interface computer program, which infringe Cisco's copyrights in the Cisco IOS Copyrighted Works. Arista has numerous publicly available webpages dedicated to encouraging and overseeing the use of its products that incorporate

[203] Arista's answer to Cisco's Second Amended Complaint at ¶ 55.

Cisco's copyright works through product documentation, training,[204] forums, or support.[205] The only reason for selling products to customers and supplying customers with supporting documents is to encourage Arista's customers to use its products that incorporate Cisco's copyright works. In fact, Arista has publicly admitted that at least 80% of its customers consider this infringing functionality to be an important factor in their decisions to purchase Arista's products.[206]

257. There also is evidence that Arista has knowledge that its acts materially contribute to its distributors' and/or customers' infringement of Cisco's copyrights. Instead of developing alternatives to Cisco's copyrighted works, Arista touts the similarity between its accused products and Cisco's IOS copyrighted works in marketing and other public materials as a selling point for customers—specifically targeting Cisco's existing customer base. For example, when Arista executive Anshul Sadana was asked at his deposition if he told customers that Arista's CLI was just like Cisco's CLI, he did not deny it and ultimately admitted it:

> 13 Q. Are you denying, sir, that you told Arista
> 14 customers that your CLI is just like Cisco's CLI?
> 15 A. That's not what you asked.
> 16 Q. I'm asking you that question right now.
> 4 Q. Are you denying, sir, that you told Arista
> 5 customers that your CLI is just like Cisco's CLI?
> 6 A. That's not what you asked.
> 7 Q. I'm asking you that question right now.

[204] Deposition of Sadana (Rough) Tr. at 111:5-21, 112:20-113:3, 114:17-116:1, 116:19-117:4, 117:16-19, 118:15-120:1, 120:18-121:19, 123:16-124:8, 125:6-12, (May 26, 2016); Deposition of Sadana (Rough) Tr. at 101:6-9, 104:3-17 (May 27, 2016).

[205] *See, e.g.*, https://www.arista.com/en/support/product-documentation; https://www.arista.com/en/support/hands-on-training; http://solutions.arista.com/training; http://solutions.arista.com/workshop-training ("Understanding the capabilities of the EOS CLI and Linux Bash access" including various modules on the EOS CLI); https://www.arista.com/en/support/customer-support; https://eos.arista.com/.

[206] CSI-CLI-00540078 at CSI-CLI-00540079.

Are you denying, sir, that you told Arista customers that your CLI is just like Cisco's CLI?
A. I'm not denying that.
Q. You said that, correct?
A. No. Yeah, I said that.
Q. Yeah?
A. Yeah.
Q. And others have said that at Arista, correct?
A. Yes --

Anshul Sadana Deposition Tr. at 236:4-17. Furthermore, Arista has admitted in numerous documents that it encourages (or has encouraged) its customers to utilize Cisco's copyrighted works when using Arista's products.[207] In other words, Arista's public statements and actions, including its sale of networking products that contain computer programs and/or other works that infringe Cisco's copyrights, cause infringement of Cisco's copyrights by Arista's distributors and customers. And Arista intentionally encourages its distributors and/or customers to infringe Cisco's copyrights, in the hopes that Arista can win Cisco customers.

258. It is my understanding that vicarious liability requires third party copying, profit to the defendant, and an ability for the defendant to supervise the infringing activity. I conclude that Arista uses and sells its devices that include EOS and profits directly from its customers' purchase and use of materials that copy original expressions from Cisco's IOS copyrighted works—indeed, it is a publicly traded company that sells products running EOS for a profit. Arista also has a direct financial interest in the exploitation of Cisco's copyrighted materials by

[207] *E.g.*, ARISTANDCA11996066, ARISTANDCA104437, ARISTANDCA1206372, ANI-ITC-944_945-3473603, ARISTANDCA1199299, ANI-ITC-944_945-3927203, ARISTANDCA10499890, ARISTANDCA_SW_105998, CSI-ANI-00381280, ARISTANDCA11411864, ARISTANDCA10499890, ANI-ITC-944_945-3452525, ARISTANDCA1194925, CSI-CLI-00540078, Packet Pushers Clip (Audio File) (Duda Exh. 274), Sadana Deposition, Exhibit 382, at 78, Posting of Kenneth Duda to Arista EOS Central, "Linux as a Switch Operating System: Five Lessons Learned" (Nov. 5, 2013), ***available at***https://eos.arista.com/linux-as-a-switch-operating-system-five-lessons-learned/.

its customers and distributors: Arista is a publicly traded company and derives value from the sale of products that contain computer programs and/or other works that infringe Cisco's copyrights. Furthermore, Arista has the right and ability to supervise at least the use, reproduction, distribution, and/or public display of computer programs and/or other works that infringe Cisco's copyrights by at least Arista's distributors and/or customers.

IX. CISCO'S COPYRIGHTED WORKS WERE NOT COPIED FROM STANFORD

259. I understand that Arista generally alleges that Cisco may not own its copyrighted works because they "are not Cisco's intellectual property, are derived from prior works over which Cisco has no ownership rights with respect to copyright assertions, and/or may not be asserted by Cisco in a copyright infringement action."[208] Specifically, I understand that Arista has made vague allegations relating to work Mr. Lougheed did at Stanford, on "TOPS-20," and worked related to SUMEX.[209]

260. Although Arista has not formulated a clear theory or argument setting forth with any specificity which of the copyrighted works it contends came from Stanford or TOPS-20, I have nevertheless reviewed Mr. Lougheed's deposition testimony, spoken with Mr. Lougheed, and reviewed the source code relating to Arista's Stanford allegations.[210] In sum, I have not seen any evidence that the multi-word command expressions (along with their specific associated modes and prompts) asserted in this case—or any of the other elements at issue in this case from the copyrighted works—originated from anywhere other than Cisco, nor have I seen any

[208] Arista's response to Interrogatory No. 10.

[209] *Id.*

[210] *See also, e.g.*, KL-00000564; KL-00000186; KL-00000381; KL-00000655, KL-00000251; KL-SC-00000033 to 52; KL-00000001.

evidence to suggest that Cisco copied them. In fact, Cisco has provided voluminous information detailing the provenance of the multi-word command expressions at issue in this case.[211]

261. Further, in my opinion, the source code Mr. Lougheed worked on while at Stanford is different than the source code he developed during that same time for Cisco. Mr. Lougheed confirmed this to me as well.[212] The fact that certain single word commands or protocols—e.g., "show," "clear," "help," "ip," "no," "arp," "bgp"—existed before Cisco does not show (or prove) that any of Cisco's copyrighted works were copied, nor does it suggest to me that the copyrighted works are unoriginal. If Arista puts forth a more coherent and clear theory or argument in its expert report that actually explains what its allegations are, I reserve the right to supplement this report and/or respond to such allegations.

X. CONCLUSION

262. For presentation of my testimony at trial I may create and use demonstratives, videos, and/or additional screenshots of the copyrighted works described in this report. In addition, I may demonstrate the use of one or more Arista and Cisco switches at trial in support of my testimony.

263. I reserve the right to supplement or amend my opinions in response to opinions expressed by Arista's experts, or in light of any additional evidence, testimony, discovery or other information that may be provided to me after the date of this report. In addition, I reserve the right to consider and testify about issues that may be raised by Arista's fact witnesses and

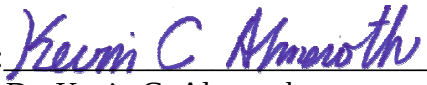
---

[211] *See* Cisco's responses to Arista's Interrogatory Nos. 2, 16, 19.

[212] Conversation with Kirk Lougheed (June 2, 2016); *see also* Lougheed Deposition Tr. 129:5-130:19, 166:24-169:16 ("I didn't like his lack of hierarchy"; "I started building a hierarchy") (Nov. 20, 2015); Lougheed Deposition Tr. 332:6-23, 339:18-340:9 (April 4, 2016).

experts at trial. I also reserve the right to modify or to supplement my opinions as a result of ongoing expert discovery or testimony at trial.

I certify under penalty of perjury that the foregoing is true and correct.

By: 

Dr. Kevin C. Almeroth
June 3, 2016

Kevin C. Almeroth

Professor, Department of Computer Science
University of California
Santa Barbara, CA 93106-5110
(805)636-1123 (office)
(805)893-8553 (fax)
almeroth@cs.ucsb.edu (email)
http://www.cs.ucsb.edu/~almeroth (WWW URL)

Education

Ph.D.	June 1997	*Georgia Institute of Technology*	Computer Science
		Dissertation Title: Networking and System Support for the Efficient, Scalable Delivery of Services in Interactive Multimedia Systems	
		Minor: Telecommunications Public Policy	
M.S.	June 1994	*Georgia Institute of Technology*	Computer Science
		Specialization: Networking and Systems	
B.S.	June 1992	*Georgia Institute of Technology*	Information and Computer Science
(high honors)		*Minors*: Economics, Technical Communication, American Literature	

Employment History

Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 2005 -- present
Associate Dean	College of Engineering University of California Santa Barbara, CA	Mar 2007 -- Aug 2009
Vice Chair	Department of Computer Science University of California Santa Barbara, CA	Jul 2000 -- Nov 2005
Associate Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 2001 -- Jun 2005
Assistant Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 1997 -- Jun 2001

Graduate Researcher	Broadband Telecommunications Center Georgia Center for Adv Telecom Tech Atlanta, GA	Sep 1996--Jun 1997
Graduate Intern	IBM T.J. Watson Research Labs Hawthorne, NY	Jun 1995--Sep 1995
Support Specialist	Office of Information Technology Georgia Institute of Technology Atlanta, GA	Sep 1995--Jun 1997
Research Assistant	College of Computing Georgia Institute of Technology Atlanta, GA	Jan 1994--Mar 1994
Graduate Intern	Hitachi Telecommunications Norcross, GA	Jun 1992--Sep 1992

Industry Technical Advising

Board of Directors	The New Media Studio Santa Barbara, CA	Nov 2006 -- present
Co-Founder & Chairman of the Board	Santa Barbara Labs, LLC Santa Barbara, CA	Sep 2007 -- Dec 2009
Board of Advisors	Techknowledge Point Santa Barbara, CA	May 2001 -- Dec 2007
Technical Advisory Board	Occam Networks, Inc. Santa Barbara, CA	May 2000 -- Dec 2010
Board of Advisors	Airplay Inc. San Francisco, CA	Jun 2005 -- Aug 2009
Consultant	Lockheed Martin Corporation San Jose, CA	Nov 1999 -- Jun 2009
Board of Advisors	Santa Barbara Technology Group Santa Barbara, CA	Sep 2000 -- Dec 2004
Board of Directors	Virtual Bandwidth, Inc. Santa Barbara, CA	Nov 2000 -- Jun 2001
Board of Advisors & Affiliated Scientist	Digital Fountain San Francisco, CA	Jan 2000 -- Dec 2001
Senior Technologist	IP Multicast Initiative, Stardust Forums Campbell, CA	Jun 1998 -- Dec 2000

I. Teaching

A. Courses Taught

CS 176A	Intro to Computer Communication Networks	Fall 1997, Fall 1998, Fall 2002, Fall 2003, Fall 2004, Spring 2005, Spring 2006, Spring 2007, Spring 2008, Fall 2008, Fall 2009, Fall 2010, Fall 2011, Fall 2012, Fall 2013, Fall 2014
CS 176B	Network Computing	Winter 2000, Winter 2001, Winter 2002, Winter 2012, Winter 2014, Winter 2015
MAT 201B	Media Networks and Services	Fall 1999, Fall 2000, Fall 2001, Fall 2003
CS 276	Distributed Computing and Computer Networks	Winter 1999, Spring 2000, Fall 2002, Fall 2005
CS 290I	Networking for Multimedia Systems	Winter 1998, Spring 1999, Fall 2004, Winter 2010
CS 595N	Technology and Society	Winter 2005, Fall 2005, Spring 2006, Fall 2006, Spring 2007, Fall 2007, Spring 2008, Fall 2008, Spring 2009
CS 595N	Economic Systems Seminar	Winter 2004, Spring 2004, Winter 2005, Spring 2005
CS 595N	Networking Seminar	Winter 1999, Fall 1999, Winter 2003
CS 595N	Wireless Networking & Multimedia Seminar	Fall 2000
CS 595I	Systems Design and Implementation Seminar	Fall 1999, Fall 2000, Winter 2001, Spring 2001, Winter 2002, Spring 2002

B. Other Teaching Experience

- *The Evolution of Advanced Networking Services: From the ARPAnet to Internet2*, Instructor, Summer 2001. Short course taught at Escuela de Ciencias Informatica (ECI) sponsored by the Universidad de Buenos Aires.
- *Johns Hopkins Center for Talented Youth*, Instructor, Summer 1994. CTY is a program to teach gifted high school students the fundamentals of computer science.
- *Georgia Institute of Technology*, Graduate Teaching Assistant, Sep 1994--Sep 1996. Worked as a TA for 12 quarters teaching 7 different courses (4 undergraduate and 3 graduate).

C. Ph.D. Students Advised [14 graduated]

14. Daniel Havey
    Research Area: *Throughput and Delay on the Packet Switched Internet*
    Date Graduated: Winter 2015
    First Position: Microsoft
13. Lara Deek (co-advised with E. Belding)
    Research Area: *Resource-Efficient Wireless Systems for Emerging Wireless Networks*
    Date Graduated: Summer 2014
    First Position: Post Doc, UIUC
12. Mike Wittie

Research Area: *Towards Sustained Scalability of Communication Networks*
Date Graduated: Summer 2011
First Position: Assistant Professor, Montana State University

11. Allan Knight
Research Area: *Supporting Integration of Educational Technologies and Research of Their Effects on Learning*
Date Graduated: Summer 2009
First Position: Research Scientist, Citrix Online

10. Hangjin Zhang
Research Area: *Towards Blended Learning: Educational Technology to Improve and Assess Teaching and Learning*
Date Graduated: Spring 2009
First Position: Microsoft

9. Gayatri Swamynathan
Dissertation Title: *Towards Reliable Reputations for Distributed Applications*
Date Graduated: Spring 2008
First Position: Zynga

8. Amit Jardosh (co-advised with E. Belding)
Dissertation Title: *Adaptive Large-Scale Wireles Networks: Measurements, Protocol Designs, and Simulation Studies*
Date Graduated: Fall 2007
First Position: Yahoo!

7. Khaled Harras
Dissertation Title: *Protocol and Architectural Challenges in Delay and Disruption Tolerant Networks*
Date Graduated: Summer 2007
First Position: Assistant Professor, Carnegie Mellon University

6. Krishna Ramachandran (co-advised with E. Belding)
Dissertation Title: *Design, Deployment, and Management of High-Capacity Wireless Mesh Networks*
Date Graduated: Winter 2006
First Position: Research Scientist, Citrix Online

5. Robert Chalmers
Dissertation Title: *Improving Device Mobility with Intelligence at the Network Edge*
Date Graduated: Summer 2004
First Position: President and CEO, Limbo.net

4. Prashant Rajvaidya
Dissertation Title: *Achieving Robust and Secure Deployment of Multicast*
Date Graduated: Spring 2004
First Position: President and CTO, Mosaic Networking

3. Sami Rollins
Dissertation Title: *Overcoming Resource Constraints to Enable Content Exchange Applications in Next-Generation Environments*
Date Graduated: Spring 2003
First Position: Assistant Professor, Mount Holyoke College

2. Srinivasan Jagannathan
Dissertation Title: *Multicast Tree-Based Congestion Control and Topology Management*
Date Graduated: Spring 2003
First Position: Consultant, Kelly & Associates

1. Kamil Sarac
Dissertation Title: *Supporting a Robust Multicast Service in the Global Infrastructure*
Date Graduated: Spring 2002
First Position: Assistant Professor, UT-Dallas

D. M.S. Students Advised (Thesis/Project Option) [19 graduated and 1 current]

20. Greg Parsons
    Research Area: *Drone-Based Mesh Networks*
    Date Started: Fall 2014
19. Neer Shey
    Research Area: *Analyzing Content Distribution Through Opportunistic Contact for Smart Cellular Phones*
    Date Graduated: Spring 2010
18. Camilla Fiorese
    Research Area: *Analysis of a Pure Rate-Based Congestion Control Algorithm*
    Date Graduated: Summer 2009
17. Brian Weiner
    Research Area: *Multi-Socket TCP: A Simple Approach to Improve Performance of Real-Time Applications over TCP*
    Date Graduated: Fall 2007
16. Avijit Sen Mazumder
    Research Area: *Facilitating Robust Multicast Group Management*
    Date Graduated: Fall 2005
15. Rishi Matthew
    Thesis Title: *Providing Seamless Access to Multimedia Content on Heterogeneous Platforms*
    Date Graduated: Summer 2004
14. Camden Ho
    Research Area: *Tools and Techniques for Wireless Network Management*
    Date Graduated: Spring 2004
13. Amit Jardosh (co-advised with E. Belding)
    Research Area: *Realistic Environment Models for Mobile Network Evaluation*
    Date Graduated: Spring 2004
12. Nitin Solanki
    Research Area: *SongWand: A Wireless Barcode Scanner Using Bluetooth Technology*
    Date Graduated: Winter 2004
11. Vrishali Wagle (co-advised with E. Belding)
    Research Area: *An Ontology-Based Service Discovery Mechanism*
    Date Graduated: Winter 2004
10. Uday Mohan
    Thesis Title: *Scalable Service Discovery in Mobile Ad hoc Networks*
    Date Graduated: Spring 2003
9. Krishna Ramachandran
    Thesis Title: *Ubiquitous Multicast*
    Date Graduated: Spring 2003
8. John Slonaker
    Thesis Title: *Inductive Loop Signature Acquisition Techniques*
    Date Graduated: Spring 2002
7. Mohammad Battah
    Thesis Title: *Dedicated Short-Range Communications Intelligent Transportation Systems Protocol (DSRC-ITS)*
    Date Graduated: Spring 2002
6. Kevin Vogel
    Thesis Title: *Integrating E-Commerce Applications into Existing Business Infrastructures*
    Date Graduated: Spring 2001
5. Sami Rollins
    Thesis Title: *Audio XmL: Aural Interaction with XML Documents*
    Date Graduated: Winter 2000
4. Andy Davis

Thesis Title: *Stream Scheduling for Data Servers in a Scalable Interactive TV System*
Date Graduated: Spring 1999

3. David Makofske
Thesis Title: *MHealth: A Real-Time Graphical Multicast Monitoring Tool*
Date Graduated: Winter 1999

2. Prashant Rajvaidya
Thesis Title: *MANTRA: Router-Based Monitoring and Analysis of Multicast Traffic*
Date Graduated: Winter 1999

1. Alex DeCastro (co-advised with Yuan-Fang Wang)
Thesis Title: *Web-Based Collaborative 3D Modeling*
Date Graduated: Winter 1998

E. Teaching Awards

2006-2007 UCSB Academic Senate Distinguished Teaching Award
2004-2005 Computer Science Outstanding Faculty Member
2000-2001 UCSB Spotlight on Excellence Award
1999-2000 Computer Science Outstanding Faculty Member (co-recipient)
1998-1999 Computer Science Outstanding Faculty Member (co-recipient)
1997-1998 Computer Science Outstanding Faculty Member

II. Research

A. Journal Papers, Magazine Articles, Books, and Book Chapters

62. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "A Practical Framework for 802.11 MIMO Rate Adaptation," Computer Networks, vol. 83, num. 6, pp. 332-348, June 2015.

61. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "Intelligent Channel Bonding in 802.11n WLANs," IEEE Transactions on Mobile Computing, vol. 13, num. 6, pp. 1242-1255, June 2014.

60. H. Zhang and K. Almeroth, "Alternatives for Monitoring and Limiting Network Access to Students in Network-Connected Classrooms," Journal of Interactive Learning Research (JILR), vol. 24, num. 3, pp. 237-265, July 2013.

59. M. Tavakolifard and K. Almeroth, "A Taxonomy to Express Open Challenges in Trust and Reputation Systems," Journal of Communications, vol. 7, num. 7, pp. 538-551, July 2012.

58. M. Tavakolifard and K. Almeroth, "Social Computing: An Intersection of Recommender Systems, Trust/Reputation Systems, and Social Networks," IEEE Network, vol. 26, num. 4, pp. 53-58, July/August 2012.

57. M. Tavakolifard, K. Almeroth, and P. Ozturk, "Subjectivity Handling of Ratings for Trust and Reputation Systems: An Abductive Reasoning Approach," International Journal of Digital Content Technology and its Applications (JDCTA), vol. 5, num. 11, pp. 359-377, November 2011.

56. R. Raghavendra, P. Acharya, E. Belding and K. Almeroth, "MeshMon: A Multi-Tiered Framework for Wireless Mesh Network Monitoring," Wireless Communications and Mobile Computing (WCMC) Journal, vol. 11, num. 8, pp. 1182-1196, August 2011.

55. A. Knight and K. Almeroth, "Automatic Plagiarism Detection with PAIRwise 2.0," Journal of Interactive Learning Research (JILR), vol. 22, num. 3, pp. 379-400, July 2011.

54. V. Kone, M. Zheleva, M. Wittie, B. Zhao, E. Belding, H. Zheng, and K. Almeroth, "AirLab: Consistency, Fidelity and Privacy in Wireless Measurements," ACM Computer Communications Review, vol. 41, num. 1, pp. 60-65, January 2011.

53. G. Swamynathan, K. Almeroth, and B. Zhao, "The Design of a Reliable Reputation System," Electronic Commerce Research Journal, vol. 10, num. 3-4, pp. 239-270, December 2010.

52. P. Acharya, A. Sharma, E. Belding, K. Almeroth and K. Papagiannaki, "Rate Adaptation in Congested Wireless Networks through Real-Time Measurements," IEEE Transactions on Mobile Computing, vol. 9, num. 11, pp. 1535-1550, November 2010.

51. R. Raghavendra, E. Belding, K. Papagiannaki, and K. Almeroth, "Unwanted Link Layer Traffic in Large IEEE 802.11 Wireless Networks," IEEE Transactions on Mobile Computing, vol. 9, num. 9, pp. 1212-1225, September 2010.

50. H. Zhang and K. Almeroth, "Moodog: Tracking Student Activity in Online Course Management Systems," Journal of Interactive Learning Research (JILR), vol. 21, num. 3, pp. 407-429, July 2010.

49. R. Chertov and K. Almeroth, "Qualitative Comparison of Link Shaping Techniques," International Journal of Communication Networks and Distributed Systems, vol. 5, num. 1/2, pp. 109-129, July 2010.

48. A. Knight and K. Almeroth, "Fast Caption Alignment for Automatic Indexing of Audio," International Journal of Multimedia Data Engineering and Management, vol. 1, num. 2, pp. 1-17, April-June 2010.

47. K. Harras and K. Almeroth, "Scheduling Messengers in Disconnected Clustered Mobile Networks," Ad Hoc & Sensor Wireless Networks, vol. 9, num. 3-4, pp. 275-304, March-April 2010.

46. A. Jardosh, K. Papagiannaki, E. Belding, K. Almeroth, G. Iannaccone, and B. Vinnakota, "Green WLANs: On-Demand WLAN Infrastructures," ACM Journal on Mobile Networks and Applications (MONET), vol. 14, num. 6, pp. 798-814, December 2009.

45. M. Wittie, K. Harras, K. Almeroth, and E. Belding, "On the Implications of Routing Metric Staleness in Delay Tolerant Networks," Computer Communications Special Issue on Delay and Disruption Tolerant Networking, vol. 32, num. 16, pp. 1699-1709, October 2009.

44. K. Harras, L. Deek, C. Holman, and K. Almeroth, "DBS-IC: An Adaptive Data Bundling System for Intermittent Connectivity," Computer Communications Special Issue on Delay and Disruption Tolerant Networking, vol. 32, num. 16, pp. 1687-1698, October 2009.

43. S. Karpinski, E. Belding, K. Almeroth, and J. Gilbert, "Linear Representations of Network Traffic," ACM Journal on Mobile Networks and Applications (MONET), vol. 14, num. 4, pp. 368-386, August 2009.

42. K. Harras and K. Almeroth, "Controlled Flooding in Disconnected Sparse Mobile Networks," Wireless Communications and Mobile Computing (WCMC) Journal, vol. 9, num. 1, pp. 21-33, January 2009.

41. R. Mayer, A. Stull, K. DeLeeuw, K. Almeroth, B. Bimber, D. Chun, M. Bulger, J. Campbell, A. Knight, and H. Zhang, "Clickers in College Classrooms: Fostering Learning with Questioning Methods in Large Lecture Classes," Contemporary Educational Psychology, vol. 34, num. 1, pp. 51-57, January 2009.

40. A. Knight, K. Almeroth, and B. Bimber, "Design, Implementation and Deployment of PAIRwise," Journal of Interactive Learning Research (JILR), vol. 19, num. 3, pp. 489-508, July 2008.

39. A. Garyfalos and K. Almeroth, "Coupons: A Multilevel Incentive Scheme for Information Dissemination in Mobile

Networks," IEEE Transactions on Mobile Computing, vol. 7, num. 6, pp. 792-804, June 2008.

38. I. Sheriff, K. Ramachandran, E. Belding, and K. Almeroth, "A Multi-Radio 802.11 Mesh Network Architecture," ACM Journal on Mobile Networks and Applications (MONET), vol. 13, num. 1-2, pp. 132-146, April 2008.

37. M. Bulger, R. Mayer, K. Almeroth, and S. Blau, "Measuring Learner Engagement in Computer-Equipped College Classrooms," Journal of Educational Multimedia and Hypermedia, vol. 17, num. 2, pp. 129-143, April 2008.

36. G. Swamynathan, B. Zhao, and K. Almeroth, "Exploring the Feasibility of Proactive Reputations," Concurrency and Computation: Practice and Experience, vol. 20, num. 2, pp. 155-166, February 2008.

35. G. Swamynathan, B. Zhao, K. Almeroth, and H. Zheng, "Globally Decoupled Reputations for Large Distributed Networks," Advances in Multimedia, vol. 2007, pp. 1-14, 2007.

34. R. Mayer, A. Stull, J. Campbell, K. Almeroth, B. Bimber, D. Chun and A. Knight, "Overestimation Bias in Self-reported SAT Scores," Educational Psychology Review, vol. 19, num. 4, pp. 443-454, December 2007.

33. P. Namburi, K. Sarac and K. Almeroth, "Practical Utilities for Monitoring Multicast Service Availability," Computer Communications Special Issue on Monitoring and Measurement of IP Networks, vol. 29, num. 10, pp. 1675-1686, June 2006.

32. R. Chalmers, G. Krishnamurthi and K. Almeroth, "Enabling Intelligent Handovers in Heterogeneous Wireless Networks," ACM Journal on Mobile Networks and Applications (MONET), vol. 11, num. 2, pp. 215-227, April 2006.

31. H. Lundgren, K. Ramachandran, E. Belding, K. Almeroth, M. Benny, A. Hewatt, A. Touma and A. Jardosh, "Experience from the Design, Deployment and Usage of the UCSB MeshNet Testbed," IEEE Wireless Communications, vol. 13, num. 2, pp. 18-29, April 2006.

30. R. Mayer, K. Almeroth, B. Bimber, D. Chun, A. Knight and A. Campbell, "Technology Comes to College: Understanding the Cognitive Consequences of Infusing Technology in College Classrooms," Educational Technology, vol. 46, num. 2, pp. 48-53, March-April 2006.

29. A. Garyfalos and K. Almeroth, "A Flexible Overlay Architecture for Mobile IPv6 Multicast," Journal on Selected Areas in Communications (JSAC) Special Issue on Wireless Overlay Networks Based on Mobile IPv6, vol. 23, num. 11, pp. 2194-2205, November 2005.

28. K. Sarac and K. Almeroth, "Monitoring IP Multicast in the Internet: Recent Advances and Ongoing Challenges," IEEE Communications, vol. 43, num. 10, pp. 85-91, October 2005.

27. K. Sarac and K. Almeroth, "Application Layer Reachability Monitoring for IP Multicast," Computer Networks, vol. 48, num. 2, pp. 195-213, June 2005.

26. A. Jardosh, E. Belding, K. Almeroth and S. Suri, "Real-world Environment Models for Mobile Network Evaluation," Journal on Selected Areas in Communications Special Issue on Wireless Ad hoc Networks, vol. 23, num. 3, pp. 622-632, March 2005.

25. S. Rollins and K. Almeroth, "Evaluating Performance Tradeoffs in a One-to-Many Peer Content Distribution Architecture," Journal of Internet Technology, vol. 5, num. 4, pp. 373-387, Fall 2004.

24. K. Sarac and K. Almeroth, "Tracetree: A Scalable Mechanism to Discover Multicast Tree Topologies in the Network," IEEE/ACM Transactions on Networking, vol. 12, num. 5, pp. 795-808, October 2004.

23. K. Sarac and K. Almeroth, "A Distributed Approach for Monitoring Multicast Service Availability," Journal of Network and Systems Management, vol. 12, num. 3, pp. 327-348, September 2004.

22. P. Rajvaidya, K. Ramachandran and K. Almeroth, "Managing and Securing the Global Multicast Infrastructure," Journal of Network and Systems Management, vol. 12, num. 3, pp. 297-326, September 2004.

21. P. Rajvaidya and K. Almeroth, "Multicast Routing Instabilities," IEEE Internet Computing, vol. 8, num. 5, pp. 42-49, September/October 2004.

20. D. Johnson, R. Patton, B. Bimber, K. Almeroth and G. Michaels, "Technology and Plagiarism in the University: Brief Report of a Trial in Detecting Cheating," Association for the Advancement of Computing in Education (AACE) Journal, vol. 12, num. 3, pp. 281-299, Summer 2004.

19. R. Chalmers and K. Almeroth, "A Security Architecture for Mobility-Related Services," Journal of Wireless Personal Communications, vol 29, num. 3, pp. 247-261, June 2004.

18. B. Stiller, K. Almeroth, J. Altmann, L. McKnight, and M. Ott, "Pricing for Content in the Internet," Computer Communications, vol. 27, num. 6, pp. 522-528, April 2004.

17. S. Rollins and K. Almeroth, "Lessons Learned Deploying a Digital Classroom," Journal of Interactive Learning Research (JILR), vol. 15, num. 2, pp. 169-185, April 2004.

16. S. Jagannathan and K. Almeroth, "A Dynamic Pricing Scheme for E-Content at Multiple Levels-of-Service," Computer Communications, vol. 27, num. 4, pp. 374-385, March 2004.

15. K. Almeroth, "Using Satellite Links in the Delivery of Terrestrial Multicast Traffic," Internetworking and Computing over Satellites, Kluwer Academic Publishers, 2003.

14. R. Chalmers and K. Almeroth, "On the Topology of Multicast Trees," IEEE/ACM Transactions on Networking, vol. 11, num. 1, pp. 153-165, January 2003.

13. S. Jagannathan, J. Nayak, K. Almeroth, and M. Hofmann, "On Pricing Algorithms for Batched Content Delivery Systems," Electronic Commerce Research and Applications Journal, vol. 1, num. 3-4, pp. 264-280, Fall 2002.

12. D. Makofske and K. Almeroth, "Multicast Sockets: Practical Guide for Programmers," *Morgan Kaufmann Publishers*, November 2002.

11. S. Jagannathan and K. Almeroth, "Price Issues in Delivering E-Content On-Demand," ACM Sigecom Exchanges, vol. 3, num. 2, pp. 18-27, May 2002.

10. D. Makofske and K. Almeroth, "From Television to Internet Video-on-Demand: Techniques and Tools for VCR-Style Interactivity," Software: Practice and Experience, vol. 31, num. 8, pp. 781-801, July 2001.

9. K. Sarac and K. Almeroth, "Supporting Multicast Deployment Efforts: A Survey of Tools for Multicast Monitoring," Journal on High Speed Networking, Special Issue on Management of Multimedia Networking, vol. 9, num. 3/4, pp. 191-211, March 2001.

8. K. Almeroth, "Adaptive, Workload-Dependent Scheduling for Large-Scale Content Delivery Systems," Transactions on Circuits and Systems for Video Technology, *Special Issue on Streaming Video*, vol. 11, num. 3, pp. 426-439, March 2001.

7. D. Makofske and K. Almeroth, "Real-Time Multicast Tree Visualization and Monitoring," Software: Practice and Experience, vol. 30, num. 9, pp. 1047-1065, July 2000.

6. M. Ammar, K. Almeroth, R. Clark and Z. Fei, "Multicast Delivery of WWW Pages," Electronic Commerce Technology Trends: Challenges and Opportunities, IBM Press, February 2000.

5. K. Almeroth, "The Evolution of Multicast: From the MBone to Inter-Domain Multicast to Internet2 Deployment," IEEE Network Special Issue on Multicasting, vol. 10, num. 1, pp. 10-20, January/February 2000.

4. K. Almeroth and M. Ammar, "An Alternative Paradigm for Scalable On-Demand Applications: Evaluating and Deploying the Interactive Multimedia Jukebox," IEEE Transactions on Knowledge and Data Engineering Special Issue on Web Technologies, vol. 11, num. 4, pp 658-672, July/August 1999.

3. K. Almeroth and M. Ammar, "The Interactive Multimedia Jukebox (IMJ): A New Paradigm for the On-Demand Delivery of Audio/Video," Computer Networks and ISDN Systems, vol. 30, no. 1, April 1998.

2. K. Almeroth and M. Ammar, "Multicast Group Behavior in the Internet's Multicast Backbone (MBone)," IEEE Communications, vol. 35, no. 6, pp. 124-129, June 1997.

1. K. Almeroth and M. Ammar, "On the Use of Multicast Delivery to Provide a Scalable and Interactive Video-on-Demand Service," Journal on Selected Areas of Communication (JSAC), vol. 14, no. 6, pp. 1110-1122, August 1996.

B. Conference Papers with Proceedings (refereed)

89. D. Havey and K. Almeroth, "Active Sense Queue Management (ASQM)," *IFIP Networking Conference*, Toulouse, FRANCE, May 2015.

88. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "Joint Rate and Channel Width Adaptation in 802.11 MIMO Wireless Networks," IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), New Orleans, LA, USA, June 2013.

87. D. Havey and K. Almeroth, "Fast Wireless Protocol: A Network Stack Design for Wireless Transmission," *IFIP Networking Conference*, Brooklyn, New York, USA, May 2013.

86. M. Tavakolifard, J. Gulla, K. Almeroth, J. Ingvaldsen, G. Nygreen, and E. Berg, "Tailored News in the Palm of Your HAND: A Multi-Perspective Transparent Approach to News Recommendation," *Demo Track at the International World Wide Web Conference (WWW)*, Rio de Janeiro, BRAZIL, May 2013.

85. S. Patterson, M. Wittie, K. Almeroth, and B. Bamieh, "Network Optimization with Dynamic Demands and Link Prices," *Allerton Conference*, Monticello, Illinois, USA, October 2012.

84. D. Havey, R. Chertov, and K. Almeroth, "Receiver Driven Rate Adaptation," *ACM Multimedia Systems Conference (MMSys)*, Chapel Hill, North Carolina, USA, February 2012.

83. M. Tavakolifard and K. Almeroth, "Trust 2.0: Who to Believe in the Flood of Online Data?" *International Conference on Computing, Networking and Communications (ICNC)*, Maui, Hawaii, USA, January 2012.

82. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "The Impact of Channel Bonding on 802.11n Network Management," *ACM CoNEXT*, Tokyo, JAPAN, December 2011.

81. L. Deek, X. Zhou, K. Almeroth, and H. Zheng, "To Preempt or Not: Tackling Bid and Time-based Cheating in Online Spectrum Auctions," *IEEE Infocom*, Shanghai, CHINA, April 2011.

80. M. Wittie, V. Pejovic, L. Deek, K. Almeroth, and B. Zhao, "Exploiting Locality of Interest in Online Social Networks," *ACM CoNEXT*, Philadelphia, Pennsylvania, USA, November 2010.

79. R. Chertov and K. Almeroth, "Using BGP in a Satellite-Based Challenged Network Environment," *IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON)*, Boston, Massachusetts, USA, June 2010.

78. R. Chertov, D. Havey and K. Almeroth, "MSET: A Mobility Satellite Emulation Testbed," *IEEE Infocom*, San Diego, California, USA, March 2010.

77. B. Stone-Gross, A. Moser, C. Kruegel, E. Kirda, and K. Almeroth, "FIRE: FInding Rogue nEtworks," *Annual Computer Security Applications Conference (ACSAC)*, Honolulu, Hawaii, USA, December 2009.

76. M. Wittie, K. Almeroth, E. Belding, I. Rimac, and V. Hilt, "Internet Service in Developing Regions Through Network Coding," *IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON)*, Rome, ITALY, June 2009.

75. R. Chertov and K. Almeroth, "High-Fidelity Link Shaping," *International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (TRIDENTCOM)*, Washington DC, USA, April 2009.

74. L. Deek, K. Almeroth, M. Wittie, and K. Harras, "Exploiting Parallel Networks Using Dynamic Channel Scheduling," *International Wireless Internet Conference (WICON)*, Maui, Hawaii, USA, November 2008.

73. D. Havey, E. Barlas, R. Chertov, K. Almeroth, and E. Belding, "A Satellite Mobility Model for QUALNET Network Simulations," *IEEE Military Communications Conference (MILCOM)*, San Diego, California, USA, November 2008.

72. J. Kayfetz and K. Almeroth, "Creating Innovative Writing Instruction for Computer Science Graduate Students," *ASEE/IEEE Frontiers in Education (FIE) Conference*, Saratoga Springs, New York, USA, October 2008.

71. G. Swamynathan, B. Zhao, K. Almeroth, and S. Rao, "Towards Reliable Reputations for Dynamic Networked Systems," *IEEE International Symposium on Reliable Distributed Systems (SRDS)*, Napoli, ITALY, October 2008.

70. B. Stone-Gross, D. Sigal, R. Cohn, J. Morse, K. Almeroth, and C. Krugel, "VeriKey: A Dynamic Certificate Verification System for Public Key Exchanges," *Conference on Detection of Intrusions and Malware & Vulnerability Assessment (DIMVA)*, Paris, FRANCE, July 2008.

69. P. Acharya, A. Sharma, E. Belding, K. Almeroth, K. Papagiannaki, "Congestion-Aware Rate Adaptation in Wireless Networks: A Measurement-Driven Approach," *IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON)*, San Francisco, California, USA, June 2008.

68. A. Jardosh, P. Suwannatat, T. Hollerer, E. Belding, and K. Almeroth, "SCUBA: Focus and Context for Real-time Mesh Network Health Diagnosis," *Passive and Active Measurement Conference (PAM)*, Cleveland, Ohio, USA, April 2008.

67. B. Stone-Gross, C. Wilson, K. Almeroth, E. Belding, H. Zheng, K. Papagiannaki, "Malware in IEEE 802.11 Wireless Networks," *Passive and Active Measurement Conference (PAM)*, Cleveland, Ohio, USA, April 2008.

66. R. Raghavendra, E. Belding, K. Papagiannaki, and K. Almeroth, "Understanding Handoffs in Large IEEE 802.11 Wireless Networks," *Internet Measurement Conference (IMC)*, San Diego, California, USA, October 2007.

65. M. Wittie, B. Stone-Gross, K. Almeroth and E. Belding, "MIST: Cellular Data Network Measurement for Mobile Applications," *IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets)*, Raleigh, North Carolina, USA, September 2007.

64. S. Karpinski, E. Belding, K. Almeroth, "Wireless Traffic: The Failure of CBR Modeling," *IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets)*, Raleigh, North Carolina, USA, September 2007.

63. A. Knight, K. Almeroth, H. Zhang, R. Mayer, and K. DeLeeuw, "Data Cafe: A Dining Car Approach to Educational Research Data Management and Distribution," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Vancouver, CANADA, June 2007.

62. H. Zhang, K. Almeroth, A. Knight, M. Bulger, and R. Mayer, "Moodog: Tracking Students' Online Learning Activities," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*,

Vancouver, CANADA, June 2007.

61. M. Bulger, K. Almeroth, R. Mayer, D. Chun, A. Knight, H. Collins, "Effects of Instructor Engagement on Student Use of a Course Management System," Assocation for Psychological Science (APS) Annual Conference, Washington DC, USA, May 2007.

60. R. Mayer, A. Stull, K. Almeroth, B. Bimber, D. Chun, M. Bulger, J. Campbell, Allan Knight, and H. Zhang, "Using Technology-Based Methods to Foster Learning in Large Lecture Classes: Evidence for the Pedagogic Value of Clickers," *American Educational Research Association (AERA) Annual Conference*, Chicago, Illinois, USA, April 2007.

59. K. Ramachandran, I. Sheriff, E. Belding, and K. Almeroth, "Routing Stability in Static Wireless Mesh Networks," *Passive and Active Measurement Conference (PAM)*, Louvain-la-neuve, BELGIUM, April 2007.

58. G. Swamynathan, T. Close, S. Banerjee, R. McGeer, B. Zhao, and K. Almeroth, "Scalable Access Control For Web Services," *International Conference on Creating, Connecting and Collaborating through Computing (C5)*, Kyoto, JAPAN, January 2007.

57. A. Knight, M. Bulger, K. Almeroth, and H. Zhang, "Is Learning Really a Phone Call Away? Knowledge Transfer in Mobile Learning," *World Conference on Mobile Learning (mLearn)*, Banff, Alberta, CANADA, October 2006.

56. J. Kurian, K. Sarac, and K. Almeroth, "Defending Network-Based Services Against Denial of Service Attacks," *International Conference on Computer Communication and Networks (IC3N)*, Arlington, Virginia, USA, October 2006.

55. A. Jardosh, K. Sanzgiri, E. Belding and K. Almeroth, "IQU: Practical Queue-Based User Association Management for WLANs--Case Studies, Architecture, and Implementation," ACM Mobicom, Marina del Rey, California, USA, September 2006.

54. C. Holman, K. Harras, and K. Almeroth, "A Proactive Data Bundling System for Intermittent Mobile Connections," IEEE International Conference on Sensor and Ad Hoc Communications and Networks (SECON), Reston, Virginia, USA, September 2006.

53. G. Banks, M. Cova, V. Felmetsger, K. Almeroth, R. Kemmerer and G. Vigna, "SNOOZE: toward a Stateful NetwOrk prOtocol fuzZEr," *Information Security Conference (ISC)*, Samos Island, GREECE, September 2006.

52. K. Harras and K. Almeroth, "Inter-Regional Messenger Scheduling in Delay Tolerant Mobile Networks," *IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM)*, Niagara Falls, New York, USA, June 2006.

51. M. Bulger, R. Mayer, and K. Almeroth, "Engaged By Design: Using Simulation to Promote Active Learning," **Outstanding Paper** at the *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Orlando, Florida, USA, June 2006.

50. A. Knight, K. Almeroth, R. Mayer, D. Chun, and B. Bimber, "Observations and Recommendations for Using Technology to Extend Interaction," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Orlando, Florida, USA, June 2006.

49. H. Zhang, and K. Almeroth, "A Simple Classroom Network Access Control System," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Orlando, Florida, USA, June 2006.

48. K. Harras and K. Almeroth, "Transport Layer Issues in Delay Tolerant Mobile Networks," *IFIP Networking Conference*, Coimbra, PORTUGAL, May 2006.

47. R. Mayer, A. Stull, J. Campbell, K. Almeroth, B. Bimber, D. Chun and A. Knight, "Some Shortcomings of Soliciting Students' Self-Reported SAT Scores," *American Educational Research Association (AERA) Annual*

Conference, San Francisco, California, USA, April 2006.

46. K. Ramachandran, E. Belding, K. Almeroth, and M. Buddhikot, "Interference-Aware Channel Assignment in Multi-Radio Wireless Mesh Networks," *IEEE Infocom*, Barcelona, SPAIN, April 2006.

45. A. Jardosh, K. Ramachandran, K. Almeroth, and E. Belding, "Understanding Congestion in IEEE 802.11b Wireless Networks," *ACM/USENIX Internet Measurement Conference (IMC)*, Berkeley, California, USA, October 2005.

44. H. Zhang, K. Almeroth and M. Bulger, "An Activity Monitoring System to Support Classroom Research," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Montreal, Quebec, CANADA, pp. 1444-1449, June 2005.

43. Z. Xiang, H. Zhang, J. Huang, S. Song and K. Almeroth, "A Hidden Environment Model for Constructing Indoor Radio Maps," *IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM)*, Taormina, ITALY, June 2005.

42. K. Harras, K. Almeroth and E. Belding, "Delay Tolerant Mobile Networks (DTMNs): Controlled Flooding in Sparse Mobile Networks," *IFIP Networking Conference*, Waterloo, Ontario, CANADA, May 2005.

41. A. Garyfalos and K. Almeroth, "Coupons: Wide Scale Information Distribution for Wireless Ad Hoc Networks," *IEEE Global Telecommunications Conference (Globecom) Global Internet and Next Generation Networks Symposium*, Dallas, Texas, USA, pp. 1655-1659, December 2004.

40. A. Knight and K. Almeroth, "DeCAF: A Digital Classroom Application Framework," *IASTED International Conference on Communications, Internet and Information Technology (CIIT)*, St. Thomas, US Virgin Islands, November 2004.

39. P. Namburi, K. Sarac and K. Almeroth, "SSM-Ping: A Ping Utility for Source Specific Multicast," *IASTED International Conference on Communications, Internet and Information Technology (CIIT)*, St. Thomas, US Virgin Islands, November 2004.

38. K. Ramachandran, E. Belding and K. Almeroth, "DAMON: A Distributed Architecture for Monitoring Multi-hop Mobile Networks," *IEEE International Conference on Sensor and Ad Hoc Communications and Networks (SECON)*, Santa Clara, California, USA, October 2004.

37. A. Garyfalos and K. Almeroth, "Coupon Based Incentive Systems and the Implications of Equilibrium Theory," *IEEE Conference on Electronic Commerce (CEC)*, San Diego, California, USA, pp. 213-220, July 2004.

36. A. Knight, K. Almeroth and B. Bimber, "An Automated System for Plagiarism Detection Using the Internet," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Lugano, Switzerland, pp. 3619-3625, June 2004.

35. H. Zhang and K. Almeroth, "Supplement to Distance Learning: Design for a Remote TA Support System," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Lugano, Switzerland, pp. 2821-2830, June 2004.

34. U. Mohan, K. Almeroth and E. Belding, "Scalable Service Discovery in Mobile Ad hoc Networks," *IFIP Networking Conference*, Athens, Greece, pp. 137-149, May 2004.

33. V. Thanedar, K. Almeroth and E. Belding, "A Lightweight Content Replication Scheme for Mobile Ad hoc Environments," *IFIP Networking Conference*, Athens, Greece, pp. 125-136, May 2004.

32. R. Chalmers and K. Almeroth, "A Mobility Gateway for Small-Device Networks," *IEEE International Conference on Pervasive Computing and Communications (PerCom)*, Orlando, Florida, USA, March 2004.

31. A. Jardosh, E. Belding, K. Almeroth and S. Suri, "Towards Realistic Mobility Models For Mobile Ad hoc

Networks," *ACM Mobicom*, San Diego, California, USA, September 2003.

30. K. Sarac, P. Namburi and K. Almeroth, "SSM Extensions: Network Layer Support for Multiple Senders in SSM," *International Conference on Computer Communication and Networks (IC3N)*, Dallas, Texas, USA, October 2003.

29. K. Ramachandran and K. Almeroth, "MAFIA: A Multicast Management Solution for Access Control and Traffic Filtering," *IEEE/IFIP Conference on Management of Multimedia Networks and Services (MMNS)*, Belfast, Northern Ireland, September 2003.

28. J. Humfrey, S. Rollins, K. Almeroth, and B. Bimber, "Managing Complexity in a Networked Learning Environment," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Honolulu, Hawaii, USA, pp. 60-63, June 2003.

27. K. Almeroth, S. Rollins, Z. Shen, and B. Bimber, "Creating a Demarcation Point Between Content Production and Encoding in a Digital Classroom," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Honolulu, Hawaii, USA, pp. 2-5, June 2003.

26. M. Kolsch, K. Kvilekval, and K. Almeroth, "Improving Speaker Training with Interactive Lectures," *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Honolulu, Hawaii, USA, June 2003.

25. P. Rajvaidya and K. Almeroth, "Analysis of Routing Characteristics in the Multicast Infrastructure," *IEEE Infocom*, San Francisco, California, USA, April 2003.

24. S. Rollins and K. Almeroth, "Pixie: A Jukebox Architecture to Support Efficient Peer Content Exchange," *ACM Multimedia*, Juan Les Pins, FRANCE, December 2002.

23. S. Rollins, R. Chalmers, J. Blanquer, and K. Almeroth, "The Active Information System(AIS): A Model for Developing Scalable Web Services," *IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA)*, Kauai, Hawaii, USA, August 2002.

22. S. Rollins and K. Almeroth, "Seminal: Additive Semantic Content for Multimedia Streams," *IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA)*, Kauai, Hawaii, USA, August 2002.

21. B. Stiller, K. Almeroth, J. Altmann, L. McKnight, and M. Ott, "Content Pricing in the Internet," *SPIE ITCom Conference on Internet Performance and Control of Network Systems (IPCNS)*, Boston, Massachusetts, USA, July 2002.

20. S. Jagannathan, J. Nayek, K. Almeroth and M. Hofmann, "A Model for Discovering Customer Value for E-Content," *ACM International Conference on Knowledge Discovery and Data Mining (SIGKDD)*, Edmonton, Alberta, CANADA, July 2002.

19. S. Rollins and K. Almeroth, "Deploying and Infrastructure for Technologically Enhanced Learning," **Outstanding Paper** at the *World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA)*, Denver, Colorado, USA, pp. 1651-1656, June 2002.

18. P. Rajvaidya and K. Almeroth, "Building the Case for Distributed Global Multicast Monitoring," *Multimedia Computing and Networking (MMCN)*, San Jose, California, USA, January 2002.

17. S. Jagannathan and K. Almeroth, "An Adaptive Pricing Scheme for Content Delivery Systems," *IEEE Global Internet*, San Antonio, Texas, USA, November 2001.

16. K. Sarac and K. Almeroth, "Providing Scalable Many-to-One Feedback in Multicast Reachability Monitoring Systems," *IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS)*, Chicago, Illinois, USA, October 2001.

15. S. Jagannathan and K. Almeroth, "The Dynamics of Price, Revenue and System Utilization," *IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS)*, Chicago, Illinois, USA, October 2001.

14. A. Kanwar, K. Almeroth, S. Bhattacharyya, and M. Davy, "Enabling End-User Network Monitoring via the Multicast Consolidated Proxy Monitor," *SPIE ITCom Conference on Scalability and Traffic Control in IP Networks (STCIPN)*, Denver, Colorado, USA, August 2001.

13. S. Jagannathan and K. Almeroth, "Using Tree Topology for Multicast Congestion Control," *International Conference on Parallel Processing (ICPP)*, Valencia, SPAIN, September 2001.

12. P. Rajvaidya and K. Almeroth, "A Router-Based Technique for Monitoring the Next-Generation of Internet Multicast Protocols," *International Conference on Parallel Processing (ICPP)*, Valencia, SPAIN, September 2001.

11. R. Chalmers and K. Almeroth, "Modeling the Branching Characteristics and Efficiency Gains of Global Multicast Trees," *IEEE Infocom*, Anchorage, Alaska, USA, April 2001.

10. R. Chalmers and K. Almeroth, "Developing a Multicast Metric," *Global Internet*, San Francisco, California, USA, December 2000.

9. K. Sarac and K. Almeroth, "Monitoring Reachability in the Global Multicast Infrastructure," *IEEE International Conference on Network Protocols (ICNP)*, Osaka, JAPAN, November 2000.

8. K. Almeroth, "A Long-Term Analysis of Growth and Usage Patterns in the Multicast Backbone (MBone)," *IEEE INFOCOM*, Tel Aviv, ISRAEL, March 2000.

7. K. Almeroth, K. Obraczka and D. De Lucia, "A Lightweight Protocol for Interconnecting Heterogeneous Devices in Dynamic Environments," *IEEE International Conference on Multimedia Computing and Systems (ICMCS)*, Florence, ITALY, June 1999.

6. K. Almeroth and M. Ammar, "The Interactive Multimedia Jukebox (IMJ): A New Paradigm for the On-Demand Delivery of Audio/Video," **Best Paper** at *the Seventh International World Wide Web Conference (WWW)*, Brisbane, AUSTRALIA, April 1998.

5. K. Almeroth, M. Ammar and Z. Fei, "Scalable Delivery of Web Pages Using Cyclic Best-Effort (UDP) Multicast," *IEEE INFOCOM*, San Francisco, California, USA, June 1998.

4. K. Almeroth and M. Ammar, "Delivering Popular Web Pages Using Cyclic Unreliable Multicast (Extended Abstract)," *SPIE Conference on Voice, Video and Data Communications*, Dallas, Texas, USA, November 1997.

3. K. Almeroth, A. Dan, D. Sitaram and W. Tetzlaff, "Long Term Resource Allocation in Video Delivery Systems," *IEEE INFOCOM*,Kobe, JAPAN, April 1997.

2. K. Almeroth and M. Ammar, "On the Performance of a Multicast Delivery Video-On-Demand Service with Discontinuous VCR Actions," *International Conference on Communications (ICC)*, Seattle, Washington, USA, June 1995.

1. K. Almeroth and M. Ammar, "A Scalable, Interactive Video-On-Demand Service Using Multicast Communication," *International Conference on Computer Communication and Networks (IC3N)*, San Francisco, California, USA, September 1994.

C. Workshop Papers (refereed)

34. M. Tavakolifard, J. Gulla, K. Almeroth, F. Hopfgartner, B. Kille, T. Plumbaum, A. Lommatzsch, T. Brodt, A.

Bucko, and T. Heintz, "Workshop and Challenge on News Recommender Systems," *ACM RecSys News Recommender Systems (NRS) Workshop and Challange*, Hong Kong, CHINA, October 2013.

33. M. Tavakolifard, K. Almeroth, and J. Gulla, "Does Social Contact Matter? Modelling the Hidden Web of Trust Underlying Twitter," *ACM International Workshop on Social Recommender Systems (SRS)*, Rio de Janeiro, BRAZIL, May 2013.

32. D. Johnson, E. Belding, K. Almeroth and G. van Stam, "Internet Usage and Performance Analysis of a Rural Wireless Network in Macha, Zambia," *ACM Networked Systems for Developing Regions (NSDR) Workshop*, San Francisco, California, USA, June 2010.

31. D. Havey, R. Chertov, and K. Almeroth, "Wired Wireless Broadcast Emulation," *International Workshop on Wireless Network Measurement (WiNMee)*, Seoul, Korea, June 2009.

30. R. Raghavendra, P. Acharya, E. Belding, and K. Almeroth, "MeshMon: A Multi-Tiered Framework for Wireless Mesh Network Monitoring," *ACM Mobihoc Wireless of the Students, by the Students, for the Students Workshop (S3)*, New Orleans, Louisiana, USA, May 2009.

29. G. Swamynathan, C. Wilson, B. Boe, B. Zhao, and K. Almeroth, "Do Social Networks Improve e-Commerce: A Study on Social Marketplaces," *ACM Sigcomm Workshop on Online Social Networks (WOSN)*, Seattle, Washington, USA, August 2008.

28. R. Raghavendra, E. Belding, and K. Almeroth, "Antler: A Multi-Tiered Approach to Automated Wireless Network Management," *IEEE Workshop on Automated Network Management (ANM)*, Phoenix, Arizona, USA, April 2008.

27. S. Karpinski, E. Belding, and K. Almeroth, "Towards Realistic Models of Wireless Workload," *International Workshop on Wireless Network Measurement (WiNMee)*, Limassol, CYPRUS, April 2007.

26. K. Harras, M. Wittie, K. Almeroth, and E. Belding, "ParaNets: A Parallel Network Architecture for Challenged Networks," *IEEE Workshop on Mobile Computing Systems and Applications (HotMobile)*, Tucson, Arizona, USA, February 2007.

25. H. Caituiro-Monge, K. Almeroth, M. del Mar Alvarez-Rohena, "Friend Relay: A Resource Sharing Framework for Mobile Wireless Devices," *ACM International Workshop on Wireless Mobile Applications and Services on WLAN Hotspots (WMASH)*, Los Angeles, California, September 2006.

24. G. Swamynathan, Ben Y. Zhao and K. Almeroth, "Exploring the Feasibility of Proactive Reputations," *International Workshop on Peer-to-Peer Systems (IPTPS)*, Santa Barbara, California, USA, February 2006.

23. G. Swamynathan, Ben Y. Zhao and K. Almeroth, "Decoupling Service and Feedback Trust in a Peer-to-Peer Reputation System," *International Workshop on Applications and Economics of Peer-to-Peer Systems (AEPP)*, Nanjing, CHINA, November 2005.

22. K. Ramachandran, M. Buddhikot, G. Chandranmenon, S. Miller, E. Belding, and K. Almeroth, "On the Design and Implementation of Infrastructure Mesh Networks," *IEEE Workshop on Wireless Mesh Networks (WiMesh)*, Santa Clara, California, USA, September 2005.

21. A. Jardosh, K. Ramachandran, K. Almeroth and E. Belding, "Understanding Link-Layer Behavior in Highly Congested IEEE 802.11b Wireless Networks," Sigcomm Workshop on Experimental Approaches to Wireless Network Design and Analysis (EWIND), Philadelphia, Pennsylvania, USA, August 2005.

20. A. Sen Mazumder, K. Almeroth and K. Sarac, "Facilitating Robust Multicast Group Management," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Skamania, Washington, USA, June 2005.

19. Y. Sun, I. Sheriff, E. Belding and K. Almeroth, "An Experimental Study of Multimedia Traffic Performance in Mesh Networks," MobiSys International Workshop on Wireless Traffic Measurements and Modeling (WitMeMo),

Seattle, Washington, USA, June 2005.

18. K. Ramachandran, K. Almeroth and E. Belding, "A Framework for the Management of Large-Scale Wireless Network Testbeds," International Workshop on Wireless Network Measurement (WiNMee), Trentino, ITALY, April 2005.

17. A. Garyfalos, K. Almeroth and K. Sanzgiri, "Deployment Complexity Versus Performance Efficiency in Mobile Multicast," *International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWiM)*, San Jose, California, USA, October 2004.

16. C. Ho, K. Ramachandran, K. Almeroth and E. Belding, "A Scalable Framework for Wireless Network Monitoring," *ACM International Workshop on Wireless Mobile Applications and Services on WLAN Hotspots (WMASH)*, Philadelphia, Pennsylvania, USA, October 2004.

15. A. Garyfalos, K. Almeroth and J. Finney, "A Hybrid of Network and Application Layer Multicast for Mobile IPv6 Networks," *International Workshop on Large-Scale Group Communication (LSGC)*, Florence, ITALY, October 2003.

14. A. Garyfalos, K. Almeroth and J. Finney, "A Comparison of Network and Application Layer Multicast for Mobile IPv6 Networks," *ACM Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, San Diego, California, USA, September 2003.

13. S. Jagannathan, and K. Almeroth, "Pricing and Resource Provisioning for Delivering E-Content On-Demand with Multiple Levels-of-Service," *International Workshop on Internet Charging and QoS Technologies (ICQT)*, Zurich, SWITZERLAND, October 2002.

12. S. Rollins, K. Almeroth, D. Milojicic, and K. Nagaraja, "Power-Aware Data Management for Small Devices," *Workshop on Wireless Mobile Multimedia (WoWMoM)*, Atlanta, GA, USA, September 2002.

11. K. Almeroth, S. Bhattacharyya, and C. Diot, "Challenges of Integrating ASM and SSM IP Multicast Protocol Architectures," *International Workshop on Digital Communications: Evolutionary Trends of the Internet (IWDC)*, Taormina, ITALY, September 2001.

10. K. Sarac and K. Almeroth, "Scalable Techniques for Discovering Multicast Tree Topology," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Port Jefferson, New York, USA, June 2001.

9. P. Rajvaidya, K. Almeroth and K. Claffy, "A Scalable Architecture for Monitoring and Visualizing Multicast Statistics," *IFIP/IEEE International Workshop on Distributed Systems: Operations & Management (DSOM)*, Austin, Texas, USA, December 2000.

8. S. Jagannathan, K. Almeroth and A. Acharya, "Topology Sensitive Congestion Control for Real-Time Multicast," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Chapel Hill, North Carolina, USA, June 2000.

7. K. Sarac and K. Almeroth, "Supporting the Need for Inter-Domain Multicast Reachability," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Chapel Hill , North Carolina, USA, June 2000.

6. D. Makofske and K. Almeroth, "MHealth: A Real-Time Multicast Tree Visualization and Monitoring Tool," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Basking Ridge New Jersey, USA, June 1999.

5. K. Almeroth and Y. Zhang, "Using Satellite Links as Delivery Paths in the Multicast Backbone (MBone)," *ACM/IEEE International Workshop on Satellite-Based Information Services (WOSBIS)*, Dallas, Texas, USA, October 1998.

4. M. Ammar, K. Almeroth, R. Clark and Z. Fei, "Multicast Delivery of Web Pages OR How to Make Web Servers

Pushy," *Workshop on Internet Server Performance (WISP)*, Madison, Wisconsin, USA, June 1998.

3. K. Almeroth and M. Ammar, "Prototyping the Interactive Multimedia Jukebox," *Mini-conference on Multimedia Appliances, Interfaces, and Trials--International Conference on Communications (ICC)*, Montreal, Quebec, CANADA, June 1997.

2. K. Almeroth and M. Ammar, "Collection and Modeling of the Join/Leave Behavior of Multicast Group Members in the MBone," *High Performance Distributed Computing Focus Workshop (HPDC)*, Syracuse, New York, USA, August 1996.

1. K. Almeroth and M. Ammar, "The Role of Multicast Communication in the Provision of Scalable and Interactive Video-On-Demand Service," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Durham, New Hampshire, USA, April 1995.

D. Non-Refereed Publications

8. K. Almeroth, E. Belding, M. Buddhikot, G. Chandranmenon, S. Miller, and K. Ramachandran, "Infrastructure Mesh Networks," *U.S. Patent Application US20070070959 A1*, September 2005.

7. K. Almeroth, R. Caceres, A. Clark, R. Cole, N. Duffield, T. Friedman, K. Hedayat, K. Sarac, M. Westerlund, "RTP Control Protocol Extended Reports (RTCP XR)," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3611*, November 2003.

6. Z. Albanna, K. Almeroth, D. Meyer, and M. Schipper, "IANA Guidelines for IPv4 Multicast Address Allocation," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3171*, August 2001.

5. B. Quinn and K. Almeroth, "IP Multicast Applications: Challenges and Solutions," *Internet Engineering Task Force (IETF), Request for Comments (RFC) 3170*, September 2001.

4. K. Almeroth, L. Wei and D. Farinacci, "Multicast Reachability Monitor (MRM) Protocol," *Internet Engineering Task Force Internet Draft*, July 2000.

3. K. Almeroth and L. Wei, "Justification for and use of the Multicast Reachability Monitor (MRM) Protocol," *Internet Engineering Task Force Internet Draft*, March 1999.

2. K. Almeroth, "Managing IP Multicast Traffic: A First Look at the Issues, Tools, and Challenges," IP Multicast Initiative White Paper, San Jose, California, USA, February 1999.

1. K. Almeroth, K. Obraczka and D. De Lucia, "Pseudo-IP: Providing a Thin Network Protocol for Semi-Intelligent Wireless Devices," *DARPA/NIST Smart Spaces Workshop*, Gaithersburg, Maryland, USA, July 1998.

E. Released Software Systems

19. ***A Multi-radio Wireless Mesh Network Architecture -- http://moment.cs.ucsb.edu/tic/.*** Released December 1, 2006 (with K. Ramachandran, I. Sheriff, and E. Belding). The software as part of a multi-radio wireless mesh network that includes a Split Wireless Router that alleviates the interference that can occur between commodity radios within a single piece of hardware. The second is server software to perform channel assignment and communicate the assignments throughout the mesh network.

18. ***AODV-Spanning Tree (AODV-ST) -- http://www.cs.ucsb.edu/~krishna/aodv-st/.*** Released September 1, 2006 (with K. Ramachandran and E. Belding). AODV-ST is an extension of the well-known AODV protocol specifically

designed for wireless mesh networks. The advantages of AODV-ST over AODV include support for high throughput routing metrics, automatic route maintenance for common-case traffic, and low route discovery latency.

17. ***The Multicast Detective -- http://www.nmsl.cs.ucsb.edu/mcast_detective/.*** Released September 1, 2005 (with A. Sen Mazumder). The multicast detective is a robust solution to determine the existence and nature of multicast service for a particular user. By performing a series of tests, a user can determine whether there is network support for multicast, and consequently, whether a multicast group join is likely to succeed.

16. ***AutoCap: Automatic and Accurate Captioning -- http://www.nmsl.cs.ucsb.edu/autocap/.*** Released August 1, 2005 (with A. Knight). AutoCap is a software system that takes as input an audio/video file and a text transcript. AutoCap creates captions by aligning the utterances in the audio/video file to the transcript. For those words that are not recognized, AutoCap estimates when the words were spoken along with an error bound that gives the content creator an idea of caption accuracy. The result is a collection of accurately time-stamped captions that can be displayed with the video.

15. ***PAIRwise Plagiarism Detection System -- http://cits.ucsb.edu/pair/.*** Released July 1, 2005 (with A. Knight). PAIRwise is a plagiarism detection system with: (1) an easy-to-use interface for submitting papers, (2) a flexible comparison engine that allows intra-class, inter-class, and Internet-based comparisons, and (3) an intuitive graphical presentation of results.

14. ***DAMON Multi-Hop Wireless Network Monitoring -- http://moment.cs.ucsb.edu/damon/.*** Released October 1, 2004 (with K. Ramachandran and E. Belding). DAMON is a distributed system for monitoring multi-hop mobile networks. DAMON uses agents within the network to monitor network behavior and send collected measurements to data repositories. DAMON's generic architecture supports the monitoring of a wide range of protocol, device, or network parameters.

13. ***Multicast Firewall -- http://www.nmsl.cs.ucsb.edu/mafia/.*** Released June 1, 2004 (with K. Ramachandran). MAFIA, a multicast firewall and traffic management solution, has the specific aim of strengthening multicast security through multicast access control, multicast traffic filtering, and DoS attack prevention.

12. ***AODV@IETF Peer Routing Software-- http://moment.cs.ucsb.edu/aodv-ietf/.*** Released November 1, 2003 (with K. Ramachandran and E. Belding). One of the first large-scale efforts to run the Ad hoc On demand Distance Vector (AODV) routing protocol in a public space (at the Internet Engineering Task Force (IETF)). The implementation includes a daemon that runs on both the Linux and Windows operating systems.

11. ***Mobility Obstacles -- http://moment.cs.ucsb.edu/mobility/.*** Released September 1, 2003 (with A. Jardosh, E. Belding, and S. Suri). The topology and movement of nodes in ad hoc protocol simulation are key factors in protocol performance. In this project, we have developed ns-2 simulation plug-ins that create more realistic movement models through the incorporation of obstacles. These obstacles are utilized to restrict both node movement and wireless transmissions.

10. ***mwalk -- http://www.nmsl.cs.ucsb.edu/mwalk/.*** Released December 1, 2000 (with R. Chalmers). Mwalk is a collection of Java applications and Perl scripts which re-create a global view of a multicast session from mtrace and RTCP logs. Users to the site can download mwalk, examine the results of our analysis, or download data sets for use in simulations dependent on multicast tree characteristics.

9. ***MANTRA2 -- http://www.nmsl.cs.ucsb.edu/mantra/.*** Released December 1, 1999 (with P. Rajvaidya). This new version of MANTRA focuses on the visualization of inter-domain routing statistics. Working in conjunction with the Cooperative Association for Internet Data Analysis (CAIDA) we have developed advanced collection and visualization techniques.

8. ***MRM -- http://www.nmsl.cs.ucsb.edu/mrm/.*** Released October 1, 1999 (with K. Sarac). MRM is the Multicast Reachability Protocol. We have implemented an end-host agent that responds to MRM Manager commands. Our end-host agent works in conjunction with Cisco routers to detect and isolate multicast faults.

7. ***MANTRA -- http://www.nmsl.cs.ucsb.edu/mantra/.*** Released January 1, 1999 (with P. Rajvaidya). MANTRA is the Monitoring and Analysis of Traffic in Multicast Routers. It uses scripts to collect and display data from backbone multicast routers.

6. ***SDR Monitor -- http://www.nmsl.cs.ucsb.edu/sdr-monitor/.*** Released January 1, 1999 (with K. Sarac). The SDR Monitor receives e-mail updates from participants containing information about observed sessions in the MBone. A global view of multicast reachability is then constructed.

5. ***The MHealth tool -- http://www.nmsl.cs.ucsb.edu/mhealth/.*** Released September 1, 1998 (with D. Makofske). The mhealth tool graphically visualizes MBone multicast group trees and provides `health' information including end-to-end losses per receiver and losses on a per hop basis. The implementation required expertise in Java, the MBone tools, and Unix.

4. ***The MControl tool -- http://www.nmsl.cs.ucsb.edu/mcontrol/.*** Released August 1, 1998 (with D. Makofske). Mcontrol is a tool to provide VCR-based interactivity for live MBone sessions. The implementation required expertise in Java, the MBone tools, and Unix.

3. ***Interactive Multimedia Jukebox (IMJ) -- http://imj.ucsb.edu/.*** Released October 1, 1996. The IMJ combines the WWW and the MBone conferencing tools to provide a multi-channel video jukebox offering both instructional and entertainment programming on a wide scale. The implementation required expertise in HTML, Perl, C, the MBone tools, and Unix.

2. ***Mlisten -- http://www.cc.gatech.edu/computing/Telecomm/mbone/.*** Released September 1, 1995. A tool to continuously collect MBone multicast group membership information including number and location of members, membership duration, and inter-arrival time for all audio and video sessions. The implementation required expertise in C, Tcl/Tk, the MBone tools, and UNIX socket programming.

1. ***Audio-on-Demand (AoD)***. March 1, 1995. A server/client prototype to demonstrate interactivity in near VoD systems. The AoD server provides songs-on-demand and VCR-like functions via multicast IP over Ethernet. The implementation required expertise in C, OpenWindows programming, UNIX socket programming, and network programming.

F. Tutorials, Panels and Invited Talks

- "25th Anniversary Panel," Network and Operating System Support for Digital Audio and Video (NOSSDAV), Portland, Oregon, USA, March 2015.
- "Sensing and Opportunistic Delivery of Ubiquitous Video in Health Monitoring, On-Campus and Social Network Applications," Workshop on Mobile Video Delivery (MoViD), Chapel Hill North Carolina, USA, February 2012.
- "Medium Access in New Contexts: Reinventing the Wheel?," USC Invited Workshop on Theory and Practice in Wireless Networks, Los Angeles, California, USA, May 2008.
- "The Wild, Wild West: Wireless Networks Need a New Sheriff," University of Florida CISE Department Lecture Series, Gainesville, Florida, USA, February 2008.
- "Distinguishing Between Connectivity, Intermittent Connectivity, and Intermittent Disconnectivity," Keynote at the ACM MobiCom Workshop on Challenged Networks (CHANTS), Montreal, CANADA, September 2007.
- "The Three Ghosts of Multicast: Past, Present, and Future," Keynote at the Trans-European Research and Education Networking Association (TERENA) Networking Conference, Lynby, DENMARK, May 2007.
- "Multicast Help Wanted: From Where and How Much?," Keynote at the Workshop on Peer-to-Peer Multicasting

(P2PM), Las Vegas, Nevada, USA, January 2007.

- "The Confluence of Wi-Fi and Apps: What to Expect Next," Engineering Insights, UC-Santa Barbara, Santa Barbara, California, USA, October 2006.
- "Challenges, Opportunities, and Implications for the Future Internet," University of Minnesota Digital Technology Center, Minneapolis, Minnesota, USA, September 2006.
- "Wireless Technology as a Catalyst: Possibilities for Next-Generation Interaction," Santa Barbara Forum on Digital Transitions, Santa Barbara, California, USA, April 2006.
- "Challenges and Opportunities in an Internet with Pervasive Wireless Access," University of Texas--Dallas Computer Science Colloquium, Dallas, Texas, USA, March 2006.
- "Challenges and Opportunities with Pervasive Wireless in the Internet," Duke University Computer Science Colloquium, Durham, North Carolina, USA, February 2006.
- "The Span From Wireless Protocols to Social Applications," Intel Research Labs, Cambridge, United Kingdom, December 2005.
- "The Internet Dot.Com Bomb and Beyond the Dot.Com Calm," CSE IGERT and Cal Poly Lecture Series, San Luis Obispo, California, USA, October 2005.
- "Panel: Directions in Networking Research," IEEE Computer Communications Workshop (CCW), Irvine, California, USA, October 2005.
- "Economic Incentives for Ad Hoc Networks," KAIST New Applications Seminar, Seoul, South Korea, March 2004.
- "New Applications for the Next Generation Internet," Citrix Systems, Santa Barbara, California, USA, March 2004.
- "PI: The Imperfect Pursuit of Pure Pattern," CITS Visions in Technology Series, Santa Barbara, California, USA, January 2004.
- "Panel: Core Networking Issues and Protocols for the Internet," National Science Foundation (NSF) Division of Advanced Networking Infrastructure and Research (ANIR) Principal Investigators Workshop, Washington DC, USA, March 2003.
- "Panel: Pricing for Content in the Internet," SPIE ITCom Internet Performance and Control of Network Systems, Boston, Massachusetts, USA, July 2002.
- "The Technology Behind Wireless LANs," Central Coast MIT Enterprise Forum, Santa Barbara, California, USA, March 2002.
- "Lessons Learned in the Digital Classroom," Center for Information and Technology Brown Bag Symposium, Santa Barbara, California, USA, March 2002.
- "The Evolution of Advanced Networking Services: From the ARPAnet to Internet2," California State University--San Luis Obispo CS Centennial Colloquium Series, San Luis Obispo, California, USA, February 2002.
- "Deployment of IP Multicast in Campus Infrastructures," Internet2 Campus Deployment Workshop, Atlanta, Georgia, USA, May 2001.
- "Multicast: Is There Anything Else to Do?," Sprint Research Retreat, Miami, Florida, USA, May 2001.
- "The Evolution of Next-Generation Internet Services and Applications," Government Technology Conference 2001 (GTC) for the Western Region, Sacramento, California, USA, May 2001.

- "I2 Multicast: Not WIDE-scale Deployment, FULL-scale Deployment," Closing Plenary, Internet2 Member Meetings, Washington, D.C., USA, March 2001.
- "Panel: Beyond IP Multicast," Content Delivery Networks (CDN), New York, New York, USA, February 2001.
- "Viable Multicast Pricing & Business Models for Wider-Scale Deployment," Content Delivery Networks (CDN), New York, New York, USA, February 2001.
- "IP Multicast: Modern Protocols, Deployment, and Management," Content Delivery Networks (CDN), New York, New York, USA, February 2001 & San Jose, California, USA, December 2001.
- "Under the Hood of the Internet," Technology 101: Technology for Investors, Center for Entrepreneurship & Engineering Management, November 2000.
- "Understanding Multicast Traffic in the Internet," (1) University of Virginia, (2) University of Maryland, and (3) Columbia University, September 2000.
- "The Bad, The Ugly, and The Good: The Past, Present, and Future of Multicast," Digital Fountain, San Francisco, California, USA, August 2000.
- "Implications of Source-Specific Multicast (SSM) on the Future of Internet Content Delivery," Occam Networks, Santa Barbara, California, USA, August 2000.
- "Introduction to Multicast Routing Protocols," UC-Berkeley Open Mash Multicast Workshop, Berkeley, California, USA, July 2000.
- "Efforts to Understand Traffic and Tree Characteristics," University of Massachusetts--Amherst Colloquia, Amherst, Massachusetts, USA, May 2000.
- "Monitoring Multicast Traffic," Sprint Research Retreat, Half Moon Bay, California, USA, April 2000.
- "What is the Next Generation of Multicast in the Internet?," HRL Laboratories, Malibu, California, USA, January 2000.
- "Mission and Status of the Center for Information Technology and Society (CITS)," Intel Research Council, Portland, Oregon, USA, September 1999.
- "Multicast at a Crossroads," IP Multicast Initiative Summits and Bandwidth Management Workshops, San Francisco, CA, USA, (1) October 1999; (2) February 2000; and (3) June 2000.
- "IP Multicast: Modern Protocols, Deployment, and Management," Networld+Interop: (1) Las Vegas, Nevada, USA--May 2000; (2) Tokyo, JAPAN--June 2000; (3) Atlanta, Georgia, USA--September 2000; (4) Las Vegas, Nevada, USA--May 2001; (5) Las Vegas, Nevada, USA--May 2002.
- "IP Multicast: Practice and Theory" (w/ Steve Deering), Networld+Interop: (1) Las Vegas, Nevada, USA--May 1999; (2) Tokyo, JAPAN--June 1999; and (3) Atlanta, Georgia, USA--September 1999.
- "Internet2 Multicast Testbeds and Applications," Workshop on Protocols for High Speed Networks (PfHSN), Salem, Massachusetts, USA, August 1999.
- "IP Multicast: Protocols for the Intra- and Inter-Domain," Lucent Technologies, Westford, Massachusetts, USA, August 1999.
- "Internet2 Multicast Testbeds and Applications," NASA Workshop: Bridging the Gap, Moffett Field, California, USA, August 1999.
- "The Evolution of Next-Generation Services and Applications in the Internet," Tektronix Distinguished Lecture

Series, Portland, Oregon, USA, May 1999.

- "Multicast Applications and Infrastructure in the Next Generation Internet," CENIC 99 Workshop on Achieving Critical Mass for Advanced Applications, Monterey, California, USA, May 1999.
- "Multicast Traffic Monitoring and Analysis Work at UCSB" (w/ P. Rajvaidya), Workshop on Internet Statistics and Metrics Analysis (ISMA), San Diego, California, USA, April 1999.
- "How the Internet Works: Following Bits Around the World," Science Lite, Santa Barbara General Affiliates and Office of Community Relations, California, USA, February 1999.
- "Managing Multicast: Challenges, Tools, and the Future," IP Multicast Initiative Summit, San Jose, California, USA, February 1999.
- "The Future of Multicast Communication and Protocols," Internet Bandwidth Management Summit (iBAND), San Jose, California, USA, November 1998.
- "An Overview of IP Multicast: Applications and Deployment," (1) Workshop on Evaluating IP Multicast as the Solution for Webcasting Real-Time Networked Multimedia Applications, New York, New York, USA, July 1998; and (2) Satellites and the Internet Conference, Washington, D.C., USA, July 1998.
- "IETF Developments in IP Multicast," IP Multicast Initiative Summit, San Jose, California, USA, February 1998.
- "An Introduction to IP Multicast and the Multicast Backbone (MBone)" vBNS Technical Meeting sponsored by the National Center for Network Engineering (NLANR), San Diego, California, USA, February 1998.
- "Using Multicast Communication to Deliver WWW Pages" Computer Communications Workshop (CCW '97), Phoenix, Arizona, USA, September 1997.

G. Research Funding

- K. Almeroth, "Packet Scheduling Using IP Embedded Transport Instrumentation," Cisco Systems Inc., $100,000, 3/1/13-8/31/14.
- K. Almeroth, E. Belding and S.J. Lee, "GOALI: Maximizing Available Bandwidth in Next Generation WLANs", National Science Foundation (NSF), $101,088, 10/1/13-9/30/14.
- K. Almeroth and E. Belding, "GOALI: Intelligent Channel Management in 802.11n Networks," National Science Foundation (NSF), $51,000, 10/1/10-9/30/11.
- B. Zhao, K. Almeroth, H. Zheng, and E. Belding, "NeTS: Medium: Airlab: Distributed Infrastructure for Wireless Measurements," National Science Foundation (NSF), $700,000, 9/1/09-8/13/13.
- K. Almeroth, E. Belding and T. Hollerer, "NeTS-WN: Wireless Network Health: Real-Time Diagnosis, Adaptation, and Management," National Science Foundation (NSF), $600,000, 10/1/07-9/30/10.
- K. Almeroth, "Next-Generation Service Engineering in Internet2," University Consortium for Advanced Internet Development (UCAID), $1,254,000, 7/1/04-6/30/09 (reviewed and renewed each year).
- B. Manjunath, K. Almeroth, F. Bullo, J. Hespanha, T. Hollerer, C. Krintz, U. Madhow, K. Rose, A. Singh, and M. Turk, "Large-Scale Multimodal Wireless Sensor Network," Office of Naval Research Defense University Research Instrumentation Program (DURIP), $655,174, 4/14/08-4/14/09.
- K. Almeroth and E. Belding, "Improving Robustness in Evolving Wireless Infrastructures," Intel Corporation,

$135,000, 7/1/06-6/30/09 (reviewed and renewed for second and third year).

- K. Almeroth and K. Sarac, "Bridging Support in Mixed Deployment Multicast Environments," Cisco Systems Inc., $100,000, 9/1/07-8/31/08.
- K. Sarac and K. Almeroth, "Building the Final Piece in One-to-Many Content Distribution," Cisco Systems Inc., $95,000, 9/1/06-8/31/07.
- E. Belding, K. Almeroth and J. Gibson, "Real-Time Communication Support in a Ubiquitous Next-Generation Internet," National Science Foundation (NSF), $900,000, 10/1/04-9/30/07.
- K. Almeroth and K. Sarac, "Improving the Robustness of Multicast in the Internet," Cisco Systems Inc., $80,000, 9/1/04-8/31/05.
- R. Mayer, B. Bimber, K. Almeroth and D. Chun, "Assessing the Pedagogical Implications of Technology in College Courses," Mellon Foundation, $350,000, 7/1/04-6/30/07.
- B. Bimber, A. Flanagin and C. Stol, "Technological Change and Collective Association: Changing Relationships Among Technology, Organizations, Society and the Citizenry," National Science Foundation (NSF), $329,175, 7/1/04-6/30/07.
- K. Almeroth and B. Bimber, "Plagiarism Detection Techniques and Software," UCSB Instructional Development, $22,000, 7/1/04-6/30/05.
- K. Almeroth, "Student Travel Support for the 14th International Workshop on Network and Operating Systems Support for Digital Audio and Video (NOSSDAV)," National Science Foundation (NSF), $10,000, 5/1/04-8/31/04.
- K. Almeroth, "An Automated Indexing System for Remote, Archived Presentations," QAD Inc., $25,000, 5/1/04-6 /30/05.
- K. Almeroth and M. Turk, "A Remote Teaching Assistant Support System," Microsoft, $40,000, 1/1/04-6/30/05.
- K. Almeroth, "Supporting Multicast Service Functionality in Helix," Real Networks, $30,000, 9/1/03-6/30/04.
- K. Almeroth and E. Belding, "Service Discovery in Mobile Networks," Nokia Summer Research Grant (U. Mohan), $10,240, 7/1/03-9/30/03.
- K. Almeroth, D. Zappala, "Building a Global Multicast Service," Cisco Systems Inc., $100,000, 1/1/03-indefinite.
- K. Almeroth, "Developing A Dynamic Protocol for Candidate Access Router Discovery," Nokia Graduate Student Fellowship (R. Chalmers), $26,110, 9/01/02-6/30/03.
- B. Bimber and K. Almeroth, "The Role of Collaborative Groupware in Organizations," Toole Family Foundation, $182,500 ($20,000 cash plus $162,500 in software), 9/1/02-indefinite.
- B. Manjunath, et al., "Digital Multimedia: Graduate Training Program in Interactive Digital Multimedia," National Science Foundation (NSF), $2,629,373, 4/1/02-3/31/07.
- J. Green, K. Almeroth, et al., "Inquiry in the Online Context: Learning from the Past, Informing the Future," UCSB Research Across Disciplines, $10,000, 9/1/01-8/31/02.
- K. Almeroth, "Monitoring and Maintaining the Global Multicast Infrastructure," Cisco Systems Inc., $54,600, 7/1/01-indefinite.
- R. Kemmerer, K. Almeroth, et al., "Hi-DRA High-speed, Wide-area Network Detection, Response, and Analysis," Department of Defense (DoD), $4,283,500, 5/1/01-4/30/06.

- A. Singh, K. Almeroth, et al., "Digital Campus: Scalable Information Services on a Campus-wide Wireless Network," National Science Foundation (NSF), 1,450,000, 9/15/00-12/31/04.
- K. Almeroth, "Visualizing the Global Multicast Infrastructure," UC MICRO w/ Cisco Systems Inc., $85,438, 7/1/00-6/30/02.
- H. Lee, K. Almeroth, et al., "Dynamic Sensing Systems," International Telemetering Foundation, $260,000, 07/01/00-06/30/04.
- B. Bimber and K. Almeroth, "Funding for the Center on Information Technology and Society," $250,000 from Dialogic (an Intel Company) and $250,000 from Canadian Pacific.
- K. Almeroth, "CAREER: From Protocol Support to Applications: Elevating Multicast to a Ubiquitous Network Service," National Science Foundation (NSF), $200,000, 9/1/00-8/31/04.
- K. Almeroth, "Characterizing Multicast Use and Efficiency in the Inter-Domain," Sprint Advanced Technology Laboratories, $62,500, 3/1/00-indefinite.
- K. Almeroth, "Producing the Next Generation of Multicast Monitoring and Management Protocols and Tools," UC MICRO w/ Cisco Systems Inc., $124,500, 7/1/99 - 6/30/01.
- K. Almeroth, "Utilizing Satellite Links in the Provision of an Inter-Wide Multicast Service," HRL Laboratories, $20,000, 7/1/99 - indefinite.
- T. Smith, K. Almeroth, et al., "Alexandria Digital Earth Prototype," National Science Foundation, $5,400,000, 4/1/99-3/31/04.
- V. Vesna, K. Almeroth, et al., "Online Public Spaces: Multidisciplinary Explorations in Multi-User Environments (OPS:MEME), Phase II," UCSB Research Across Disciplines, $50,000, 9/1/98-8/31/99.
- K. Almeroth, "Techniques and Analysis for the Provision of Multicast Route Management," UC MICRO w/ Cisco Systems Inc., $97,610, 7/1/98 - 6/30/00.
- K. Almeroth, "Capturing and Modeling Multicast Group Membership in the Multicast Backbone (MBone)," UC MICRO w/ Hughes Research Labs, $19,146, 7/1/98 - 12/31/99.
- K. Almeroth, "Building a Content Server for the Next Generation Digital Classroom," UCSB Faculty Research Grant, $5,000, 7/1/98-6/31/99.

H. Research Honors and Awards

- IEEE Fellow Status, 2013
- Finalist for Best Paper Award, IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON), June 2008
- Best Paper Award, Passive and Active Measurement (PAM) Conference, April 2007
- Outstanding Paper Award, World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA), June 2006
- IEEE Senior Member Status, 2003
- Finalist for Best Student Paper Award, ACM Multimedia, December 2002
- Outstanding Paper Award, World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA), June 2002
- Computing Research Association (CRA) Digital Government Fellowship, 2001
- National Science Foundation CAREER Award, 2000

- Best Paper Award, 7th International World Wide Web Conference, April 1998

III. Service

A. Professional Activities

1. Society Memberships

Member, Association for Computing Machinery (ACM): 1993-present
Member, ACM Special Interest Group on Communications (SIGComm): 1993-present
Fellow, Institute of Electrical and Electronics Engineers (IEEE): 1993-present
Member, IEEE Communications Society (IEEE ComSoc): 1993-present
Member, American Society for Engineering Education (ASEE): 2003-2006

2. Review Work for Technical Journals and Publishers

NSF CISE research proposals, IEEE/ACM Transactions on Networking, IEEE/ACM Transactions on Computers, IEEE/ACM Transactions on Communications, IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Multimedia, IEEE Communications, IEEE Communications Letters, IEEE Network, IEEE Internet Computing, IEEE Multimedia, IEEE Aerospace & Electronics Systems Magazine, ACM Transactions on Internet Technology, ACM Transactions on Multimedia Computing, Communications and Applications, ACM Computing Surveys, ACM Computer Communications Review, ACM Computeres in Entertainment, ACM/Springer Multimedia Systems Journal, AACE Journal of Interactive Learning (JILR), International Journal of Computer Mathematics, Journal of Communications and Networks, Journal of Parallel and Distributed Computing, Journal of Network and Systems Management, Journal of High Speed Networking, Journal of Communications and Networks, Journal on Selected Areas in Communications, Journal of Wireless Personal Communications, Personal Mobile Communications, Annals of Telecommunications, International Journal of Wireless and Mobile Computing, Pervasive and Mobile Computing (PMC), Wireless Networks Journal, Computer Networks Journal, Cluster Computing, Computer Communications, Mobile Computing and Communications Review, Performance Evaluation, Software--Practice & Experience, Information Processing Letters, ACM Sigcomm, ACM Multimedia, ACM Network and System Support for Digital Audio and Video Workshop (NOSSDAV), ACM Sigcomm Workshop on the Economics of Peer-to-Peer Systems (P2PEcon), ACM Sigcomm Workshop on Challenged Networks (CHANTS), IEEE Infocom, IEEE Globecom, IEEE Global Internet (GI) Symposium, IEEE Globecom Automatic Internet Symposium, IEEE Globecom Internet Services and Enabling Technologies (IS&ET) Symposium, IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), IEEE International Conference on Network Protocols (ICNP), IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON), IEEE International Conference on Multimedia and Exposition (ICME), IEEE International Conference on Communications (ICC), IEEE International Conference on Parallel and Distributed Systems (ICPADS) IEEE International Symposium on High-Performance Distributed Computing (HPDC), IEEE International Conference on Distributed Computing Systems (ICDCS), IEEE International Workshop on Quality of Service (IWQoS), IEEE/IFIP Network Operations and Management Symposium (NOMS), IFIP/IEEE International Symposium on Integrated Network Management (IM), IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), IEEE Aerospace & Electronics Systems Magazine, SPIE Conference on Multimedia Computing and Networking (MMCN), IFIP Networking, IASTED International Conference on Information Systems and Databases

(ISD), IASTED International Conference on Communications, Internet, and Information Technology, IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA), IASTED International Conference on European Internet and Multimedia Systems and Applications (EuroIMSA), IASTED International Conference on Communications and Computer Networks (CCN), IASTED International Conference on Software Engineering and Applications (SEA), International Conference on Computer and Information Science (ICIS), International Association for Development of the Information Society (IADIS) International Conference on the WWW/Internet, Workshop on Network Group Communication (NGC), International Conference on Next Generation Communication (CoNEXT), International Conference on Parallel Processing (ICPP), International Conference on Computer Communications and Networks (IC3N), International Workshop on Hot Topics in Peer-to-Peer Systems (Hot-P2P), International Workshop on Wireless Network Measurements (WiNMee), International Workshop on Incentive-Based Computing (IBC), International Workshop on Multi-hop Ad Hoc Networks (REALMAN), International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWIM), International Packet Video (PV) Workshop, High Performance Networking Conference (HPN), International Parallel Processing Symposium (IPPS), International Symposium on Innovation in Information & Communication Technology (ISIICT), Workshop on Coordinated Quality of Service in Distributed Systems (COQODS), Pearson Education (Cisco Press) Publishers, Macmillan Technical Publishing, and Prentice Hall Publishers.

3. Conference Committee Activities

Journal/Magazine Editorial Board

IEEE/ACM Transactions on Networking (ToN): 2003-2009, 2013-present
Journal of Network and Systems Management (JNSM): 2011-present
ACM Computers in Entertainment: 2002-present
IEEE Network: 1999-2012
AACE Journal of Interactive Learning Research (JILR): 2003-2012
IEEE Transactions on Mobile Computing (TMC): 2006-2011
ACM Computer Communications Review (CCR): 2006-2010

Journal/Magazine Guest Editorship

IEEE Journal on Selected Areas in Communications (JSAC) Special Issue on "Delay and Disruption Tolerant Wireless Communication", June 2008
Computer Communications Special Issue on "Monitoring and Measuring IP Networks", Summer 2005
Computer Communications Special Issue on "Integrating Multicast into the Internet", March 2001

Conference/Workshop Steering Committee

IEEE International Conference on Network Protocols (ICNP): 2007-present
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006-present
International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2001-present, 2005-2011 (chair), 2012-present (co-chair)
IEEE Global Internet (GI) Symposium: 2005-2013
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2005-2009

Conference/Workshop Chair

International Conference on Communication Systems and Networks (COMSNETS): 2014 (co-chair)
ACM International Conference on Next Generation Communication (CoNext): 2013 (co-chair)
ACM RecSys News Recommender Systems (NRS) Workshop and Challange: 2013 (co-chair)
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006 (co-chair)

IEEE International Conference on Network Protocols (ICNP): 2003 (co-chair), 2006
International Workshop on Wireless Network Measurements (WiNMee): 2006 (co-chair)
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2002 (co-chair)
International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2002 (co-chair), 2003 (co-chair)
IEEE Global Internet (GI) Symposium: 2001 (co-chair)
International Workshop on Networked Group Communication (NGC): 2000 (co-chair)

Program Chair

International Conference on Computer Communication and Networks (ICCCN): 2015 (Track co-chair)
International Conference on Communication Systems and Networks (COMSNETS): 2010
IEEE International Conference on Network Protocols (ICNP): 2008 (co-chair)
IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON): 2007 (co-chair)
IFIP Networking: 2005 (co-chair)

Posters/Demonstrations Chair

ACM Sigcomm: 2012 (co-chair)

Student Travel Grants Chair

ACM Sigcomm: 2010 (co-chair)

Publicity Chair

IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2004 (co-chair)

Keynote Chair

IEEE Infocom: 2005 (co-chair)

Local Arrangements Chair

Internet2 "Field of Dreams" Workshop: 2000

Tutorial Chair

ACM Multimedia: 2000
IEEE International Conference on Network Protocols (ICNP): 1999

Panel/Session Organizer

NSF ANIR PI 2003 Panel on "Core Networking Issues and Protocols for the Internet"
CCW 2001 Session on "Multicast/Peer-to-Peer Networking"
NOSSDAV 2001 Panel on "Multimedia After a Decade of Research"
NGC 2000 Panel on "Multicast Pricing"

Technical Program Committee

IEEE International Conference on Network Protocols (ICNP): 1999, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, 2009 (Area Chair), 2010 (Area Chair), 2011 (Area Chair), 2012 (Area Chair), 2013, 2014 (Area Chair), 2015 (Area Chair), 2016 (Area Chair)
International Workshop on Network and Operating System Support for Digital Audio and Video

(NOSSDAV): 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016
ACM Multimedia (MM): 2001, 2003, 2004, 2005 (short paper), 2006, 2007, 2008, 2008 (short paper), 2010, 2011, 2012, 2013, 2015
IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON): 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 (Area Chair), 2012 (Area Chair), 2013, 2014 (Area Chair), 2015, 2016 (Area Chair)
IEEE/IFIP Network Operations and Management Symposium (NOMS): 2004, 2006, 2010
IEEE Infocom: 2004, 2005, 2006, 2008, 2009, 2010 (Area Chair), 2011 (Area Chair), 2012 (Area Chair)
IFIP Networking: 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2013, 2014, 2015, 2016
ACM Workshop on Mobile Video (MoVid): 2014, 2015, 2016
ACM Student Research Competition (SRC) Grand Finals: 2014
Mobile and Social Computing for Collaborative Interactions (MSC): 2014
IEEE Conference on Communications and Network Security (CNS): 2013
IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM): 2005, 2006, 2007, 2008, 2009, 2010
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006, 2008, 2009, 2010, 2011, 2012, 2016
IEEE International Conference on Distributed Computing Systems (ICDCS): 2006, 2010, 2011, 2012, 2013
International Workshop on Wireless Network Measurements (WiNMee): 2006, 2008, 2010
ACM Sigcomm: 2008 (poster), 2010
IEEE International Conference on Computer Communication and Networks (IC3N): 2008, 2009, 2010, 2011, 2012
International Conference on Communication Systems and Networks (COMSNETS): 2009, 2010, 2011, 2012, 2013
International Conference on Sensor Networks (SENSORNETS): 2012
International Workshop on Social and Mobile Computing for Collaborative Environments (SOMOCO): 2012
Workshop on Scenarios for Network Evaluation Studies (SCENES): 2009, 2010, 2011
ACM Multimedia Systems (MMSys): 2010, 2011, 2012, 2015, 2016
IEEE International Conference on Pervasive Computing and Communications (PerCom): 2010
IEEE Wireless Communications and Networking Conference (WCNC): 2010, 2011
ACM International Symposium on Mobility Management and Wireless Access (MobiWac): 2010, 2011
International Conference on Computing, Networking and Communications, Internet Services and Applications Symposium (ICNC-ISA): 2012, 2013
IEEE WoWMoM Workshop on Hot Topics in Mesh Networking (HotMesh): 2010, 2011, 2012, 2013
IEEE Workshop on Pervasive Group Communication (PerGroup): 2010
ACM International Conference on Next Generation Communication (CoNEXT): 2005, 2006, 2007, 2009, 2012
IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets) Wireless Communications, Networks and Systems Symposium: 2007, 2008, 2009
IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets) Internet Technologies Symposium: 2007, 2008, 2009
International Workshop on Mobile and Networking Technologies for Social Applications (MONET): 2008, 2009
Extreme Workshop on Communication-The Midnight Sun Expedition (ExtremeCom): 2009
IEEE International Workshop on Cooperation in Pervasive Environments (CoPE): 2009
International Workshop on the Network of the Future (FutureNet): 2009, 2010, 2011, 2012
IEEE International Conference on Multimedia and Exposition (ICME): 2010
SPIE Conference on Multimedia Computing and Networking (MMCN): 2004, 2008
ACM Sigcomm Workshop on the Economics of Networks, Systems, and Computation (NetEcon):

2008
IEEE International Conference on Communications (ICC): 2008
IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS): 2008
IFIP/IEEE International Symposium on Integrated Network Management (IM): 2005, 2007
Global Internet (GI) Symposium: 2001, 2002, 2004, 2006, 2007
IEEE/ACM International Conference on High Performance Computing (HiPC): 2007
ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc): 2007
IEEE Workshop on Embedded Systems for Real-Time Multimedia (ESTIMedia): 2007
IEEE/IFIP Wireless On Demand Network Systems and Services (WONS): 2007
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2001, 2002, 2003, 2004, 2005, 2006
IASTED International Conference on European Internet and Multimedia Systems and Applications (EuroIMSA): 2004, 2006
IEEE International Conference on Parallel and Distributed Systems (ICPADS): 2005, 2006
IEEE Globecom Internet Services and Enabling Technologies (IS&ET) Symposium: 2006
International Workshop on Incentive-Based Computing (IBC): 2006
IEEE International Workshop on Quality of Service (IWQoS): 2006, 2014, 2015
International Workshop on Multi-hop Ad Hoc Networks (REALMAN): 2006
IEEE Globecom Automatic Internet Symposium: 2005
ACM Sigcomm Workshop on the Economics of Peer-to-Peer Systems (P2PEcon): 2005
International Conference on Parallel Processing (ICPP): 2001, 2003, 2004
International Packet Video (PV) Workshop: 2002, 2003, 2004
IEEE International Symposium on High-Performance Distributed Computing (HPDC): 2004
ACM Sigcomm: 2004 (poster)
International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWIM): 2004
International Symposium on Innovation in Information & Communication Technology (ISIICT): 2004
Workshop on Coordinated Quality of Service in Distributed Systems (COQODS): 2004
IASTED International Conference on Networks and Communication Systems (NCS): 2004
IASTED International Conference on Communications, Internet, and Information Technology (CIIT): 2004
IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA): 2003, 2004
International Workshop on Networked Group Communication (NGC): 1999, 2000, 2001, 2002, 2003
International Association for Development of the Information Society (IADIS) International Conference on the WWW/Internet: 2003
International Conference on Computer and Information Science (ICIS): 2003
Human.Society@Internet: 2003
IASTED International Conference on Communications and Computer Networks (CCN): 2002
The Content Delivery Networks (CDN) Event: 2001
IP Multicast Initiative Summit: 1998, 1999, 2000
Corporation for Education Network Initiatives in California (CENIC): 1999
Internet Bandwidth Management Summit (iBAND): 1998, 1999

B. Technical Activities

1. Working Groups

Internet2 Working Group on Multicast, Chair: 1998-2005
IEEE Communications Society Internet Technical Committee (ITC), Conference Coordinator: 2000-2004
IETF Multicast Directorate (MADDOGS), Member: 1999-2001

IASTED Technical Committee on the Web, Internet and Multimedia, Member: 2002-2005
Internet Engineering Task Force (IETF), various working groups: 1995-present

2. Meeting Support Work

Internet Engineering Task Force MBone broadcasts: 1995-2005
Conference MBone broadcasts: Sigcomm '99, and '00
Interop+Networld Network Operations Center (NOC) Team Member: 1995-1997
ACM Multimedia technical staff: 1994

C. University of California Committees

1. Department of Computer Science Committees

Public Relations: 2005-2006 (chair 2005-2006), 2009-2011 (chair 2009-2011)
Strategic Planning: 2000-2002, 2003-2006, 2009-2011
Undergraduate Advising and Affairs: 2006-2007, 2014-2015
Vice Chair: 2000-2005
Graduate Admissions: 2000-2005 (chair 2000-2005), 2011-2012
Graduate Affairs: 2000-2005 (co-chair 2000-2005)
Teaching Administration: 2000-2005
Facilities: 1997-2001 (chair 1999-2000), 2006-2007
External Relations: 1999-2002
Computer Engineering Public Relations: 2011-2012
Computer Engineering Awards: 2011-2012
Computer Engineering Administration/Recruiting: 1998-2001
Computer Engineering Lab and Computer Support: 1998-2001
Faculty Recruiting: 1999-2002
Graduate Advising: 1998-1999, 2000-2005

2. University Committees

Member, Campus Budget and Planning: 2013-2015
Faculty, Cognitive Science Program: 2006-present
Faculty, Technology Management Program (TMP): 2003-2014
Faculty, Media Arts and Technology (MAT) Program: 1998-2014
Faculty, Computer Engineering Degree Program: 1998-present
Steering Committee, Center for Information Technology and Society (CITS): 2012-present
Associate Director, Center for Information Technology and Society (CITS): 1999-2012
Member, Campus Committee on Committees: 2010-2013
Member, Campus Income and Recharge Committee: 2010-2013
Member, College of Engineering Executive Committee: 2010-2012 (chair 2011-2012), 2014-2015 (chair 2014-2015)
Member, Distinguished Teaching Award Committee: 2009, 2010, 2011
Member, Campus Classroom Design and Renovation Committee: 2003-2010
Member, ISBER Advisory Committee: 2008-2011
Member, Fulbright Campus Review Committee: 2007
Member, Faculty Outreach Grant Program Review Committee: 2007
Executive Vice Chancellor's Information Technology Fee Committee: 2005-2006

Council on Research and Instructional Resources: 2003-2006
Executive Vice Chancellor's Working Group on Graduate Diversity: 2004-2005
Member, Engineering Pavillion Planning Committee: 2003-2005
Information Technology Board: 2001-2004
Executive Committee, Center for Entrepreneurship & Engineering Management (CEEM): 2001-2004

3. System Wide Committees

UCSB Representative to the Committee on Information Technology and Telecommunications Policy (ITTP): 2003-2005
UCSB Representative to the Executive Committee, Digital Media Innovation (DiMI): 1998-2003

D. Georgia Tech Committees and Service (while a graduate student)

Graduate Student Body President: 1994-1995
Georgia Tech Executive Board: 1994-1995
Georgia Tech Alumni Association Executive Committee: 1994-1995
Dean of Students National Search Committee: 1995
Institute Strategic Planning Committee: 1994-1996

Cases in last 4 years I have been deposed or testified:

- Two depositions in Intermec Technologies Corp. v. Palm Inc. (07-272-SLR, D. Del.). Finished: 05/12.
- A deposition in iHance, Inc. v. Eloqua Corp. (2:11-CV-257-MSD-TEM, E.D. Va.). Finished: 06/12.
- A deposition in Apple, Inc. v. Motorola Mobility, Inc. (11-CV-178 (BBC), W.D. Wis.). Finished: 10/12.
- A deposition and trial testimony in Two-Way Media LLC v. AT&T Inc., et al. (SA-09-CA-476-OLG, W.D. Tex.). Finished: 03/13.
- Depositions in British Telecommunications PLC v. CoxCom, Inc., Cox Communications, Inc., & Cable One, Inc. (10-658-SLR, D. Del.). Finished: 01/14.
- A deposition and trial testimony in Certain Digital Media Devices, Including Televisions, Blu-Ray Disc Players, Home Theater Systems, Tablets and Mobile Phones, Components Thereof and Associated Software (ITC Inv. No. 337-TA-882) [Black Hills Media v. Samsung]. Finished 02/14.
- A deposition in Inter Partes Review of U.S. Patent No. 7,107,612 (IPR2013-00369) [Palo Alto Networks, Inc. v. Juniper Networks, Inc.]. Finished 05/14.
- A deposition and trial testimony in EON Corp Holdings, LCC. v. Landis+Gyr, Inc, et al. (6:11-CV-317-LED-JDL, E.D. Tex.). Finished 06/14.
- Depositions in Straight Path IP Group, Inc. v. Bandwidth.com, Inc., Telesphere Networks Ltd., and Vocalocity, Inc. (1:13-CV-932, E.D. Va.). Finished 06/14.
- Depositions and trial testimony in Beneficial Innovations, Inc. v. Advanced Publications, Inc. et al. (2:11-CV-229-JRG-RSP, E.D. Tex.). Finished 07/14.
- Depositions in Robocast Inc. v. Apple Inc. (11-235-RGA, D. Del.) and Robocast Inc. v. Microsoft Corp. (10-1055-RGA, D. Del.). Finished 08/14.
- A deposition in PersonalWeb Technologies, LCC v. Yahoo! Inc. (6:12-CV-658-LED, E.D. Tex.). Finished 08/14.
- Depositions and trial testimony in Personal Audio LLC v. Togi Entertainment, Inc. et al. (2:13-CV-13-JRG-RSP, E.D. Tex.). Finished 09/14.
- A deposition in Inter Partes Review of U.S. Patent Nos. 8,326,924 and 8.239,451 (CBM2014-00001 and CBM2014-00050, respectively) [American Express Co. et al. v. Metasearch Systems, LLC]. Finished 09/14.
- Depositions in Inter Partes Review of U.S. Patent Nos. 6,044,062 (IPR2013-00482) and 6,249,516 (IPR2014-00147) [ABB Technology LTD v. IPCO, LLC]. Finished 10/14.
- A deposition in Inter Partes Review of U.S. Patent No. 5,995,091 (IPR2014-00153 and IPR2014-00154) [Adobe Systems Inc & Level3 Communications, LLC v. Afluo, LLC]. Finished 10/14.
- Depositions in Inter Partes Review of U.S. Patent Nos 8,145,268; 8,224,381; 8,135,398; 7,899,492; 8,050,711; and 8,712,471 (IPR2013-00569, IPR2013-00570, IPR2013-00571, IPR2013-00572, IPR2013-00573 and IPR2015-00054, respectively) [Samsung Electronics Co., LTD v. Virginia Innovation Sciences, Inc.]. Finished 11/14.
- A deposition in Black Hills Media, LLC v. Sonos, Inc. (14-cv-00486-SJC-PJWx, C.D. Cal.). Finished 02/15.
- Markman testimony in Personal Audio, LLC v. Apollo Brands et al. (1:14-CV-8-RC, E.D. Tex.). Finished 06/15.

- Depositions in Inter Partes Review of U.S. Patent Nos. 8,028,323; 8,230,099; 8,214,873; 6,108,686; 7,835,689; and 7,917,082 (IPR2014-00709, IPR2014-00711, IPR2014-00723, IPR2014-00717, IPR2014-00718, and IPR2014-00721, respectively) [Samsung Electronics Co., LTD v. Black Hills Media, LLC]. Finished 06/15.
- A deposition in Inter Partes Review of U.S. Patent No. 7,548,875 (IPR2014-01236) [MindGeek et al. v. Skky, Inc.]. Finished 06/15.
- A deposition in Inter Partes Review of U.S. Patent Nos. 7,468,661 (IPR2014-00751) [Hart Communication Foundation v. SIPCO, LLC]. Finished 07/15.
- Depositions in Inter Partes Review of U.S. Patent No. 6,754,195 (IPR2014-00552 and IPR2014-00553) [Marvell Semiconductor, Inc. v. Intellectual Ventures I LLC]. Finished 07/15.
- A deposition and trial testimony in Certain Network Devices, Related Software and Components Thereof (US ITC Inv. No. 337-TA-944) [Cisco v. Arista]. Finished 09/15.
- Depositions and trial testimony in Certain Network Devices, Related Software and Components Thereof (II) (US ITC Inv. No. 337-TA-945) [Cisco v. Arista]. Finished 12/15.
- A deposition in Inter Partes Review of U.S. Patent Nos. 6,286,045 (IPR2015-00657 and IPR2015-00660) and 6,014,698 (IPR2015-00662 and IPR2015-00666) [Google, Inc. v. At Home Bondholders Liquidated Trust]. Finished 12/15.
- A deposition in Sprint Communications Company LP v. Time Warner Cable, Inc. (11-2686-JWL, D. Kan.);
- A deposition in Cisco Systems, Inc. v. Arista Networks, Inc. (5:14-cv-5344-BLF, N.D. Cal.);
- A deposition in Certain Activity Tracking Devices, Systems, and Components Thereof (US ITC Inv. No. 337-TA-963) [Jawbone v. Fitbit].
- A deposition in Thomas C. Sisoian v. International Business Machines Corporation (A-14-CA-565-SS, W.D. Tex.)
- A deposition in Inter Partes Review of U.S. Patent Nos. 6,199,076 (IPR2015-00845) and 7,509,178 (IPR2015-00846) [Google, Inc. v. Personal Audio, LLC].

Cases in last 5 years I have been deposed or testified (I represented the underlined party):

- Two depositions in Beneficial Innovations, Inc. v. Blockdot, Inc. et al. (2:07-CV-263(TJW/CE) and 2:07-CV-555 (TJW/CE), E.D. Tex.). Finished: 10/10.
- Two depositions and trial testimony in Personal Audio, LLC v. Apple, Inc. (9:09-CV-00111-RC, E.D. Tex.). Finished: 07/11.
- Two depositions in Paltalk Holdings, Inc. v. Sony et al. (2:09-cv-274-DF-CE, E.D. Tex.). Finished: 09/11.
- A deposition and trial testimony in Certain Wireless Communication Devices, Portable Music and Data Processing Devices, Computers and Components (US ITC Inv. No. 337-TA-745) [Motorola Mobility v. Apple]. Finished: 04/12.
- Two depositions in Intermec Technologies Corp. v. Palm Inc. (07-272-SLR, D. Del.). Finished: 05/12.
- A deposition in iHance, Inc. v. Eloqua Corp. (2:11-CV-257-MSD-TEM, E.D. Va.). Finished: 06/12.
- A deposition in Apple, Inc. v. Motorola Mobility, Inc. (11-CV-178 (BBC), W.D. Wis.). Finished: 10/12.
- A deposition and trial testimony in Two-Way Media LLC v. AT&T Inc., et al. (SA-09-CA-476-OLG, W.D. Tex.). Finished: 03/13.
- Depositions in British Telecommunications PLC v. CoxCom, Inc., Cox Communications, Inc., & Cable One, Inc. (10-658-SLR, D. Del.). Finished: 01/14.
- A deposition and trial testimony in Certain Digital Media Devices, Including Televisions, Blu-Ray Disc Players, Home Theater Systems, Tablets and Mobile Phones, Components Thereof and Associated Software (ITC Inv. No. 337-TA-882) [Black Hills Media v. Samsung]. Finished 02/14.
- A deposition in Inter Partes Review of U.S. Patent No. 7,107,612 (IPR2013-00369) [Palo Alto Networks, Inc. v. Juniper Networks, Inc.]. Finished 05/14.
- A deposition and trial testimony in EON Corp Holdings, LCC. v. Landis+Gyr, Inc, et al. (6:11-CV-317-LED-JDL, E.D. Tex.). Finished 06/14.
- Depositions in Straight Path IP Group, Inc. v. Bandwidth.com, Inc., Telesphere Networks Ltd., and Vocalocity, Inc. (1:13-CV-932, E.D. Va.). Finished 06/14.
- Depositions and trial testimony in Beneficial Innovations, Inc. v. Advanced Publications, Inc. et al. (2:11-CV-229-JRG-RSP, E.D. Tex.). Finished 07/14.
- Depositions in Robocast Inc. v. Apple Inc. (11-235-RGA, D. Del.) and Robocast Inc. v. Microsoft Corp. (10-1055-RGA, D. Del.). Finished 08/14.
- A deposition in PersonalWeb Technologies, LCC v. Yahoo! Inc. (6:12-CV-658-LED, E.D. Tex.). Finished 08/14.
- Depositions and trial testimony in Personal Audio LLC v. Togi Entertainment, Inc. et al. (2:13-CV-13-JRG-RSP, E.D. Tex.). Finished 09/14.
- A deposition in Inter Partes Review of U.S. Patent Nos. 8,326,924 and 8.239,451 (CBM2014-00001 and CBM2014-00050, respectively) [American Express Co. et al. v. Metasearch Systems, LLC]. Finished 09/14.
- Depositions in Inter Partes Review of U.S. Patent Nos. 6,044,062 (IPR2013-00482) and 6,249,516 (IPR2014-00147) [ABB Technology LTD v. IPCO, LLC]. Finished 10/14.

- A deposition in Inter Partes Review of U.S. Patent No. 5,995,091 (IPR2014-00153 and IPR2014-00154) [Adobe Systems Inc & Level3 Communications, LLC v. Afluo, LLC]. Finished 10/14.
- A deposition in Black Hills Media, LLC v. Sonos, Inc. (14-cv-00486-SJC-PJWx, C.D. Cal.). Finished 02/15.
- Depositions in Inter Partes Review of U.S. Patent Nos 8,145,268; 8,224,381; and 8,135,398, (IPR2013-00569, IPR2013-00570, and IPR2013-00571, respectively) [Samsung Electronics Co., LTD v. Virginia Innovation Sciences, Inc.];
- Depositions in Inter Partes Review of U.S. Patent Nos. 8,028,323; 8,230,099; 8,214,873; 6,108,686; 7,835,689; and 7,917,082 (IPR2014-00709, IPR2014-00711, IPR2014-00723, IPR2014-00717, IPR2014-00718, and IPR2014-00721, respectively) [Samsung Electronics Co., LTD v. Black Hills Media, LLC];
- Depositions in Inter Partes Review of U.S. Patent No. 6,754,195 (IPR2014-00552 and IPR2014-00553) [Marvell Semiconductor, Inc. v. Intellectual Ventures I LLC];
- Markman testimony in Personal Audio, LLC v. Apollo Brands et al. (1:14-CV-8-RC, E.D. Tex.);
- A deposition in Inter Partes Review of U.S. Patent Nos. 7,468,661 (IPR2014-00751) [Hart Communication Foundation v. SIPCO, LLC]
- A deposition in Inter Partes Review of U.S. Patent No. 7,548,875 (IPR2014-01236) [MindGeek et al. v. Skky, Inc.];
- A deposition in Sprint Communications Company LP v. Time Warner Cable, Inc. (11-2686-JWL, D. Kan.);
- A deposition in Certain Network Devices, Related Software and Components Thereof (US ITC Inv. No. 337-TA-944) [Cisco v. Arista];

Cases With Reports/Declarations But No On-The-Record Testimony:

- Innovative Communications Technologies, Inc. v. Stalker Software, Inc. (2:12-CV-9-RGD-TEM, E.D. Va.). Finished: 11/12.
- Innovative Communications Technologies, Inc. v. ooVoo, LLC (2:12-CV-8-RGD-DEM, E.D. Va.). Finished: 11/12.
- Innovative Communications Technologies, Inc. v. Vivox, Inc. (2:12-CV-7-RGD-FBS, E.D. Va.). Finished: 11/12.
- SIPCO, LLC v. ABB, Inc. (6:11-cv-0048-LED-JDL). Finished: 12/12.
- Virginia Innovation Sciences, Inc. v. Samsung Electronics Co. LTD, Samsung Electronics America, Inc. and Samsung Telecommunications America LLC (2:12-cv-548-MSD-DEM, E.D. Va.). Finished: 04/14.
- PersonalWeb Technologies, LCC v. Google Inc. and YouTube, LLC (5:13-cv-01317 EJD, E.D. Tex.).
- Intellectual Ventures v. AT&T, CenturyLink, and Windstream (1:13-cv-00116-LY, 1:13-cv-00118-LY, 1:13-cv-00119-LY; W.D. Tex.)
- A declaration in Parallel Networks, LLC v. A10 Networks, Inc. (13-1943-LPS, D. Del.)

- A declaration in Affinity Labs of Texas, LLC v. Amazon.com Inc (6:15-cv-00029-WSS-JCM, W.D. Tex.)
- A declaration in Catharon Intellectual Property, LLC v. FedEx Corporate Services, Inc. (6:14-cv-00061-KNM, E.D. Tex.)

Cases Where I Have Been Disclosed (but no work product)

- Toddlerwatch.com v. Motorola (01-12187-REK, D. Mass.). Finished: 02/03.
- Personal Audio, LLC v. Samsung Electronics Co. Ltd. et al. (1:11-CV-432-RC, E.D. Tex.). Finished: 12/12.
- Enterasys Networks, Inc. v. Foundry Networks, LLC and Extreme Networks, Inc. (05-11298 (DPW), E.D. Mass.). Finished: 04/13.
- Mosaid Technologies, Inc. v. Dell, Inc. et al. (2:11-cv-00179-MHS-CMC, E.D. Tex.). Finished 08/13.
- Radware, Ltd. v. A10 Networks, Inc. (5:13-cv-02021-RMW, N.D. Cal.). Finished: 08/14
- Rockstar Consortium v. Google Inc. (13-cv-00893-JRG-RSP, E.D. Tex.). Finished 11/14.
- Intellectual Ventures I LLC and Intellectual Ventures II LLC v. AT&T Mobility LLC, et al. (1:12-cv-00193-LPS, D. Del.)
- OpenTV, Inc. et al. v. Apple, Inc. (14-cv-01622-JST, N.D. Cal.)
- Intellectual Ventures I LLC and Intellectual Ventures II LLC v. Symantec Corp. (13-440-(LPS), D. Del.)
- Certain Network Devices, Related Software and Components Thereof (II) (US ITC Inv. No. 337-TA-945) [Cisco v. Arista];